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EDITORIAL

AGRICULTURAL IMPLEMENTS

THE most striking feature of the peasant farm in this country is the poverty of its equipment in respect of agricultural implements. A light plough fitted not with a blade which turns the soil but with a tooth which tears a small furrow in it and a mammoty, which serves the purpose of hoe, pick, or spade as occasion demands, comprise the whole of this equipment. In the major paddy growing districts of the country even this primitive plough is unknown and the soil receives no tillage except the tread of buffaloes in the flooded field. There is no doubt that poor tillage of weed-bound lands is the chief cause of the low average yield of grain in Ceylon.

It is not possible to introduce modern power-driven plant in small peasant holdings which are sub-divided and dwindle in size from generation to generation. They will be of interest to this country only when capitalists take up extensive areas for cultivation in annual crops or middle class farmers working about 50 acres each elect to use tractors and other implements co-operatively. Nor is there any likelihood that horse-drawn ploughs and harrows of the European farmer will be adapted for use in Ceylon. They are too heavy for a pair of Ceylon oxen, and their cost, cheap as they are, is too much for the peasant who raises his crops mainly not to be exchanged for money but for personal consumption.

In these circumstances we have to turn to India for a lead for the present. Attention is drawn to the series of articles on agricultural implements in common use in India, the third of which is published in this number. The seed drill, the blade harrow, and the tooth cultivator may be turned out by any village mechanic at the cost of a few rupees. These, together with a light iron plough specially designed for local use, should form part of the dead stock on every farm, and one of the most important works of rural reconstruction that awaits attention is the creation of a credit or other financial system which will enable the peasant to secure these implements and the training of the people in their use.

AGRICULTURAL IMPLEMENTS*—III

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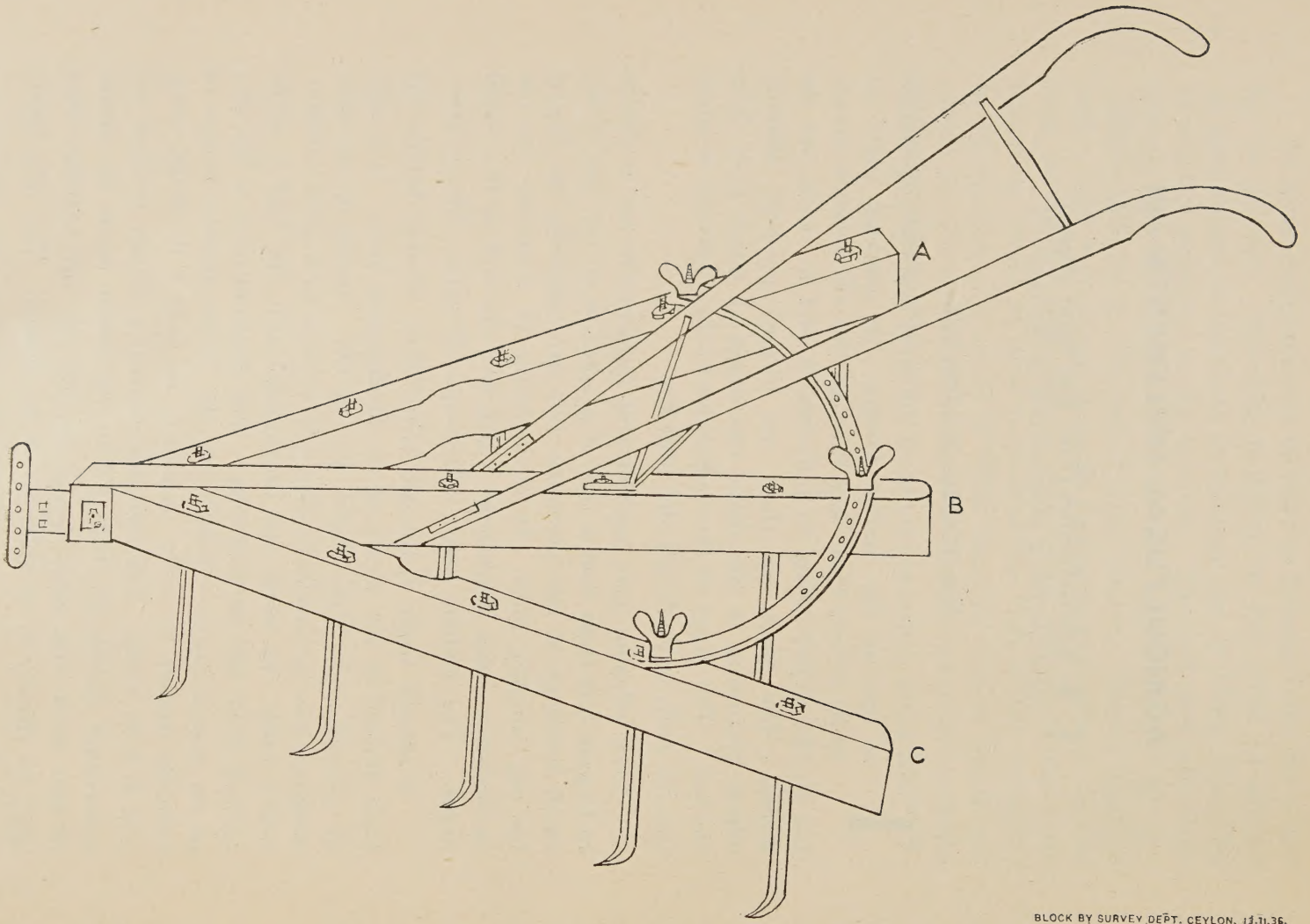
THE TOOTH CULTIVATOR

THE tooth cultivator is one of the most popular implements in use by the Indian farmer. Its working parts are made to tear their way through the soil without inverting it, the object being to pulverise it and to comb out the weeds. The tines, as these are termed produce different effects according to the shape and angle at which they enter the soil. The range of the operations of the cultivator is small but its work is thorough and uniform.

Very efficient iron agricultural implements are available in Ceylon but their cost is out of proportion to the size of the small holdings of our peasants, and are generally too heavy for our country bulls. It is necessary to introduce for use in Ceylon a cheap implement which stirs the soil up to a small depth. The Indian tooth cultivator will serve this purpose.

A simple tooth cultivator with three wooden beams has been devised by the writer at the Wariyapola farm. It weighs 54 pounds and costs about Rs. 12·50. Owing to its light weight it can be handled easily and worked by a good medium-heavy bull. To work the implement with one bull a single bullock yoke will be necessary. The diagram gives a fair idea of its construction. A.B.C. are the three wooden beams of halmilla timber, $3'' \times 2''$. A and C are each 2 ft. 10 ins. long, and B 3 ft. 2 ins. The two side beams or wings, as these are sometimes called, are fastened to the centre beam by means of two thick iron wing hinges, so that the two exterior arms may be drawn in or spread out as desired. The iron teeth,

*This series of articles describe a number of simple implements used in India and Ceylon which are suitable for general adoption by the village agriculturist—*Editor, T.A.*



BLOCK BY SURVEY DEPT, CEYLON. 13.11.36.

The Tooth Cultivator

14 in number, are set perpendicular to the beams. The ends of the teeth are forged into a lance or spear shape slightly bent forwards. The teeth run 12 inches below the beams to which they are fixed by means of nuts. The two handles, about $3\frac{1}{2}$ feet in length, are fixed on to the centre beam by means of two pieces of iron plate. The handles are further strengthened by a V-shaped bracket also fixed to the centre beam. The arms of the bracket are clamped on to the two handles by means of bolts and nuts. To separate the two wings to required distances two pieces of crescent-shaped flat iron, 18 inches long, one inch wide, and a quarter inch thick, are made use of with five sets of holes drilled in each iron. Three thumb screw nuts are fitted on to the three beams 12 inches away from the free end of the wings, and 4 inches from the free end of the centre beam. When the implement requires to be adjusted to intercultivate a particular crop, the centre thumb screw nut is removed and the wings are either brought closer or pushed further apart as desired. This implement can be used to intercultivate crops spaced in rows one foot to three feet apart. At the Wariyapola Farm tobacco, chillies, maize, napier grass, etc., are intercultivated with this implement. The depth of working is regulated by the vertical bridle. This cultivator works to a depth of about $3\frac{1}{2}$ inches. One man working for 8 hours a day can intercultivate 2 acres.

THE PRODUCTION OF CASHEW NUTS IN MANNAR

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ALTHOUGH the cashew tree is not extensively grown in Ceylon, there are a few areas situated both in the wet and dry zones of the island where it is found in small groves. It thrives, chiefly, on the sandy soils of the dry zone along the eastern coast near Batticaloa and to a lesser extent in the small island of Mannar. It receives the least amount of attention in comparison with most other crops of economic value in Ceylon and even exists wild in many of the areas where it is found, *e.g.*, in the Western Province and in the Tenmarachy Division of the Jaffna district. The chief use of the tree lies in its kernels which are sold unpeeled in the local markets after extraction by roasting and shelling of the nuts in which they are enclosed. During the season, the kernels from immature and unroasted nuts are also sold, unpeeled and raw as well as, in smaller quantities, peeled and boiled with the addition of a small amount of saffron. They are made into packets containing a handful of kernels, prepared either way as stated above and are wrapped in mango leaves folded over as a cover. They are thus sold by women vendors in Colombo.

The cashew tree is also used as a supply of firewood for the Colombo market while it is considered of much value both in the Eastern Province and in the Jaffna Peninsula as a catch crop for coconuts on the poorest soils which are improved by it as a result of the large accumulation of fallen leaves on the surface of the soil under each tree. Coconuts are planted under the shade of the cashew and in this way soils which are too poor for growing coconuts are made more suitable.

There is, however, no export trade either of the unroasted, mature nuts or of the kernels which are extracted from the

roasted and mature nuts in spite of the fact that there is a large demand for the former from the cashew factories on the west coast of India and for the latter from the United States of America.

In Mannar, there is a small but important industry in the production of cashew nuts. The tree is grown in groves of about 1 to 2 acres each and it is estimated that there are about 270 cashew groves with a total extent of about 509 acres. Cashew nuts rank third in order of production after palmyrah and coconuts in Mannar Island. It is estimated that there are about 250,000 lb. of nuts produced annually in Mannar.

The groves are enclosed by low brushwood fences. During the first 2 to 3 years these are about five feet high in order to prevent cattle and goats destroying the young plants but after this period, the brushwood is only maintained at about three feet, mainly to act as a protection against theft by the demarcation of each grove in this way. The establishment of fences enclosing each grove is considered to be one of the chief difficulties in Mannar owing to the scarcity even of brushwood which is the only material available for fencing purposes from the nearest waste lands in the Island. These brushwood fences need to be reconstructed about every six months.

SOIL CONDITIONS

It is well known that the cashew can grow in soils which are unsuitable for most other crops and in areas such as near the coast where strong winds are prevalent. It is thus found to thrive on the sandy soils of Mannar and Batticaloa but it will not grow in localities where the sub-soil water is too brackish. It is for this reason that the tree does not grow on the strip of land extending towards the west of the island for about 2 to 3 miles from the town of Mannar, the only vegetation being that of *Acacia planifrons* (T. *udai*) which is more tolerant of arid and saline conditions.

PROPAGATION

The cashew is propagated in Mannar entirely by seed, well-dried nuts being used for this purpose although the tree can be budded on its own root stock. Planting at stake is not, usually, practised as, after germination, the fleshy cotyledons or seed leaves that develop are liable to be attacked by field rats and insect pests.

As the seedlings are not easily transplanted the nuts are first germinated in palmyrah baskets—known locally as *kuddans*—which are about 9 inches high and 4½ inches in diameter.

Before germination, the nuts are dried in the sun for about 10 to 14 days. The seedlings which develop from fresh nuts are considered to be weaker and therefore more liable to insect attack. Experiments carried out in this Division on the method of germinating the nuts have indicated that they are best placed in the vertical position with the point of attachment of the nut to the fruit on top, the nut being just covered over with a thin layer of soil. Shade is provided until the seedlings have developed 3 to 4 leaves. When baskets are not available the nuts may be germinated in nursery beds covered over with a layer of straw. Watering should be given daily or as often as is necessary to keep the soil moist.

Planting in baskets is usually done between the months of June and July. Germination takes place within about 8 to 10 days and the seedlings are kept in the baskets for about a month or until such time when the tap roots become too long to remain in the baskets. By this time each seedling develops about 4 to 5 leaves and it is then transplanted in Mannar about August in the open. Holes of sufficient size are dug so as to take each plant, but on other soils which are not sandy, holes about 2 feet square and 2½ feet deep should be dug and filled with good soil.

It is advisable to have 2 to 3 seedlings in each hole and after about a year to leave only the most vigorous. In this way any losses caused in transplanting, etc. may be reduced.

As soon as the seedlings are planted out they are pot watered from small wells dug in the sand, once every two days and after about a month, once in four days until the north-east monsoon arrives. Watering when carried out is only done in the mornings, about two gallons being given to each plant. After the north-east monsoon is over, watering has again to be commenced from about January and is continued until next October when no further watering becomes necessary.

PLANTING DISTANCE

There is no definite spacing adopted for planting cashews in Mannar. There are usually not more than about 10 to 15

trees per acre though there is space available for more trees. Owing to the strong winds which prevail there the plants develop a low and spreading habit. Under these conditions, a spacing of 50 × 50 ft. is not too wide but in localities where there is some shelter from strong winds and the trees are kept pruned by removal of overhanging branches a spacing of 40 × 40 ft. could be adopted. The seedlings should first be planted out at 20 × 20 ft. apart and when they are about 7 to 10 years of age thinning out to 40 × 40 ft. should be carried out.

FLOWERING AND FRUITING

After about eighteen months, flowering and fruiting commence though until about the third year the yields are small.

The flowers usually appear between January and February and the fruits can be collected from the end of February or early March up to the end of May. There are certain late season varieties known locally as *cholagam* because they only fruit from about June to July after the south-westerly wind has set in.

VARIETIES

There are several varieties of cashew growing in Mannar which show such differences as reported in a previous article* by one of the writers, in the colour of the fruit (red, yellow or intermediate) its size and shape, as well as size and shape of the nuts and kernels, the season of bearing and the degree of shedding of flowers. From the commercial standpoint, the size and shape of the kernel as well as the percentage weight of the kernels are important.

Varieties with large sized nuts are not necessarily the best in quality. In the largest varieties examined, the kernels are found to be either flat or to fill incompletely the cavities of the shell while their percentage weight on extraction from the nuts is low. In general, the medium sized nuts averaging 50 to 60 per pound with a high percentage weight of kernels are the most desirable from the point of view of quality and yield. Selections of varieties for yield and for quality of the kernels which should be round, bold and hard as well as with a high percentage weight and of different seasons of bearing are under trial.

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* The Cashew Nut Industry of South India, by W. R. C. Paul, *The Tropical Agriculturist*, September 1936.

YIELDS

In Mannar, the yields are reckoned on the number of nuts harvested and not on the weight as in India. The large nut varieties produce a lesser number of nuts per tree than do the small nut varieties but as the number of nuts per pound is proportionately less there is generally not much difference between varieties in the weight of nuts per tree. Although accurate figures of yields are not kept by the owners of cashew trees it is reported, in general, that the good large nut varieties produce about 4,000 nuts per tree, the medium varieties about 5,000 while the smallest varieties produce about 6,000 nuts or about 80 lb. per tree in each case, the large giving about 50 the medium about 60 and the small about 80 nuts per pound. In South Kanara, the average yield is reported to be only about 20 lb. per tree though there are individual trees which give as much as 100 lb.

Although the crop is purchased in Mannar on numbers of nuts and not on weight it would not be advisable to plant the smaller nut varieties without considering the quality of the kernels as in the event of the development of the industry in Ceylon the purchase of nuts from growers is certain to be made on weight. In Mannar, however, a slightly higher price is paid for the varieties with larger nuts.

EXTRACTION OF THE KERNELS

The method adopted in Mannar for roasting the nuts is simple and no vessels of any kind are even used. Three logs, usually of *Acacia planifrons* (T. *udai*) as being the most easily available in Mannar Island, each about 3 to 4 ft. in length and about 3 to 6 inches in diameter are placed on the ground so as to meet at a point with their other ends radiating from it. The surface sand within a radius of about 6 inches from this point is scraped away to a depth of not more than about $\frac{1}{2}$ inch. The logs are lighted at their point of convergence and depending on the intensity of the fire, about 10 to 20 nuts are thrown at a time near the fire. With the aid of a small stick the nuts are moved about the surface sand so as to prevent their being charred and when they are sufficiently roasted are drawn away from the fire.

This work as well as that of shelling the roasted nuts and extracting the kernels is carried out only by women who are

skilled in these operations and it is estimated that about 2,000 nuts can be roasted and shelled a day by a woman. It is necessary for greater uniformity in roasting and in the colour of the kernels produced that the process be carried out in open pans over small, circular, earthenware furnaces as is done in the cashew factories of South India.*

Shelling is carried out by striking the nuts on their edges once or twice in each case with a piece of wood.

PRICES AND MARKETS

At present there is a ready market for cashew nuts and kernels from Mannar. These are sold at the religious festivals held during June and July at Madhu and at Anuradhapura. Jaffna, however, is a regular market throughout the year for Mannar cashew nuts.

Prices vary from about 90 cents to Re. 1·00 per 1,000 nuts and from Re. 1·40 to Re. 1·80 per 1,000 kernels or about 6 cents per pound of nuts and about 30 cents per pound of kernels.

POSSIBILITIES OF DEVELOPMENT

The expansion of the cashew areas in Mannar Island is at present limited by finance. This is due to the cost of fencing and maintenance of fences enclosing the cashew groves as well as of constructing small wells for watering the plants in the early stages.

The purchase of nuts and the extraction of the kernels is now being carried out as a cottage industry, but in view of the fact that there is an enormous demand for kernels extracted from roasted nuts in the U.S.A. and Europe, and in the event of a factory for the extraction, grading and packing of the kernels being established in Ceylon in the near future any extension in the planting of cashew nuts would be met by a suitable market.

Even before the establishment of a factory in Ceylon, the surplus nuts from such centres as Mannar and the coastal area of the Eastern Province could be disposed of in India to meet the requirements of the existing factories on the west coast. If nuts can be exported profitably from East Africa to the west coast of Ceylon there is no reason why Ceylon should not be able to do likewise.

*The Cashew Nut Industry of South India, by W. R. C. Paul, Ceylon Sessional Paper, (*in the press*).

STUDIES ON CEYLON SOILS

VII. THE CHARACTERISTICS OF FURTHER IMPORTANT SOIL GROUPS

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IN this paper, which is a continuation of the series on the important soil groups of Ceylon (1), are detailed the characteristics of typical profiles of the following soil groups : the lateritic gravelly soils (known locally as the cabooky soils), the lateritic brown loams, the white coastal sands (commonly designated the cinnamon soils) and the red sandy soils derived from Pleistocene plateau deposits (2), the chocolate red loams of Jurassic origin (3), and the paddy (gley) soils. The methods of study were on the same lines as those adopted previously. It is somewhat unfortunate that a few of the soil groups now described are related pedologically to some of those dealt with in previous papers but, since these studies are undertaken as the opportunities for so doing present themselves and simultaneously with other soil work of immediate consequence, there is no alternative but to publish the results as they are completed. It is hoped, however, in the future to collate and classify all the information obtained from these studies in some systematic manner.

THE LATERITIC GRAVELLY LOAMS

The lateritic gravelly loams or cabooky soils, as they are known in Ceylon, are a feature of the western and south-western parts of the Island, though their occurrence is not confined to these regions. They are best observed on the low hillocks and elevated land of these areas. They are of fairly extensive distribution and are formed under both humid and semi-humid

conditions from igneous and metamorphic basic and intermediate rocks. These soils are distinctly poor agriculturally, but show response to cultivation and manuring. Their drainage is good and occasionally excessive. The main crop they carry is rubber, but coconuts and tea are also grown on them, the former with no great degree of success. Cinnamon and citronella are also cultivated on these soils in certain districts. They are unsuited generally for annual crops. The surface layers of this group of soils are often severely eroded and quartz gravel and ferruginous nodules form a high proportion of the soil mass. The prevailing tint of these soils is greyish to reddish yellow but reddish soils are also observed. A typical profile is described below and the analytical data of its horizons shown in table I. The B horizon is absent in these soils.

LATERITIC GRAVELLY LOAM

Location	Pitipana, Western Province
Elevation	50 ft. (approx.)
Climate	Rainfall 100 in. (approx.); temperature 80°F. (approx.)
Geological origin	Basic and intermediate gneisses
Mode of formation	Residual
Drainage	Good
Topography	Undulating; sample taken at bottom of a slope
Vegetation	Rubber—poor growth

PROFILE

A. 0-11 in.	Greyish yellow gravelly loam; large proportion of ferruginous concretions up to 2 in. diameter; compact but friable; conglomerate to small clod; root growth good; strongly acid.
C. 11 in.-4 ft.	Reddish yellow gravelly loam; abundance of partly decomposed and undecomposed ferruginous concretions; mottled dark red; compact; conglomerate to irregular large clod; root growth absent; acid.

TABLE I

	Lateritic Gravelly Loam		*Immature Lateritic Brown Loam*	
	A	C	A	C
	%	%	%	%
MECHANICAL ANALYSIS				
Stones and gravel	55·0	63·5	5·8	0·9
Coarse sand	38·6	32·5	35·7	37·0
Fine sand	23·1	22·4	13·9	32·7
Silt	4·1	5·7	11·4	16·2
Clay	27·6	33·4	34·3	10·6
Loss by solution	2·5	2·0	1·4	1·0
Moisture	4·1	4·0	3·3	2·5
Sticky point moisture ..	21·1	20·9	26·4	17·8
Texture index number ..	25·5	30·8	32·0	11·4
Soil type	Loam	Heavy loam	Heavy loam	Light sandy loam
CHEMICAL ANALYSIS				
Loss on ignition	7·90	6·92	9·51	7·27
Organic matter	2·71	1·16	1·84	0·24
Combined water ..	5·19	5·76	7·67	7·03
Carbon	1·57	0·67	1·07	0·14
Nitrogen	0·120	0·048	0·108	0·018
Carbon/nitrogen ratio ..	13·0	13·9	10·0	7·9
Reaction pH	4·85	5·00	5·87	5·47
Total potash	0·081	0·067	0·210	0·083
Total phosphoric acid ..	0·056	0·042	0·041	0·030
Total exchangeable bases (m.e. per 100 gm. soil) ..	0·57	0·37	3·14	3·79
Exchangeable calcium ..	0·33	0·27	2·35	2·12
CLAY ANALYSIS				
Loss on ignition ..	22·82		21·68	
Silica (SiO_2)	39·10		42·34	
Sesquioxides (R_2O_3) ..	58·37		56·05	
Alumina (Al_2O_3)	45·28		42·47	
Iron oxides (Fe_2O_3) ..	13·09		13·58	
SiO_2/Al_2O_3 (molecular) ..	1·46		1·69	
SiO_2/R_2O_3 (molecular) ..	1·23		1·40	
Soil type	Lateritic		Lateritic	

An examination of table I would indicate that in both A and C horizons, the proportion of stones and gravel is very high, comprising over half and more nearly two-thirds of the soil mass. The soil proper is loamy in texture and becomes heavier with depth. The A horizon is fairly well supplied with organic matter and nitrogen but the C horizon is very dificient in these constituents. The carbon nitrogen ratios tend to remain constant throughout the profile. In reaction the soils are distinctly acid, the pH showing a slight increase with depth from 4·85 to 5·0. The soils are very poor in total mineral fertilising constituents, both potash and phosphoric acid, and the exchangeable base contents are extremely low. The clay analyses reveal an alumina content of 45 per cent. and an iron oxide content of 13 per cent. On the basis of the silica/alumina molecular ratio, this soil is lateritic, though the ratio 1·46 is near enough to justify its being described as a laterite soil.

THE LATERITIC BROWN LOAMS

The lateritic brown loams are only of very limited occurrence and may with some reason be termed immature loams, as the soil horizons immediately below the shallow top soil consist largely of loose, decomposing material like rock brash. Small flakes of mica predominate throughout the profile. The soils are probably formed from sedimentary metamorphic rocks like Khondalite and occur in soilated areas among the red and yellow earths mid-country and to a lesser extent, up-country. Agriculturally they are fairly rich soils, and are suited for cultivation of either annual or perennial crops. Ginger was grown on one such loam with excellent results. The top soil is shallow but the profile itself is of fair depth. The soils are well-drained and easily eroded. The typical profile characteristics are indicated below and the analytical data presented in table I.

LATERITIC BROWN LOAM

Location ..	.. Giragama, Kandy district
Elevation ..	.. 1,700 ft. (approx.)
Climate ..	.. Rainfall 90 in. (approx.); temperature 77°F. (approx.)
Geological origin	.. Sedimentary metamorphic rock

Mode of formation	Residual
Drainage	Very good
Topography	Undulating, sample taken from the side of a hillock
Vegetation	*Mana* grass ; tea

PROFILE

A. 0-14 in.	Brown heavy loam ; loose and friable; irregular prismatic; root growth good ; acid ; horizon indistinct
C. > 14 in.	Yellowish sand like rock brash ; very soft and loose; amorphous; root growth good ; acid.

The analytical data reveal that the A horizon is a heavy loam, while the C is a light sandy loam with a fair percentage of silt. The former is fairly well supplied with nitrogen and organic matter, but the C layer, as is to be expected, is extremely poor in these constituents. The soils are acid in reaction with pH values of 5·9 and 5·5 respectively in the two horizons. The A horizon is rich in potash and poor in phosphoric acid, but fairly well supplied with replaceable bases so far as Ceylon soils go. The C horizon is poor in potash and phosphoric acid but fair in replaceable bases. The carbon/nitrogen ratio which is about 10 in the surface soils falls to 8 in the sub-soil. The clay analyses show an alumina content of 42 per cent. and a silica/alumina molecular ratio of 1·69. The soil is therefore of the lateritic type.

SOILS DERIVED FROM PLEISTOCENE PLATEAU DEPOSITS

Under this heading the white sand of the western coastal plain, known popularly as the cinnamon soil and the reddish sandy soil from the Puttalam district will be described. Both these soils, according to Wayland (2), are residual deposits of the Pleistocene red earths. The fine earth material is considered to have been removed from them by natural causes and the red tint of the cinnamon soils to have been bleached by vegetation under swamp conditions. Tennant (4), on the other hand, attributes the sandy deposits of the Batticaloa and western coasts to the interaction between currents skirting

the coast and the sand-laden river waters. Other soils of this type have colours between these two extremes, buff being not uncommon. The colours are related to the degree of bleaching.

THE CINNAMON SOILS

These soils are best exemplified in the Negombo district. They are deep, almost white sands, poor in all plant fertilising constituents. They suffer from a deficiency of moisture during dry weather and are inclined to be water-logged during the rainy season. This is because of the occurrence in most of these soils at depths varying from 6 to 15 feet or more of a blackish brown, fairly impervious pan-like layer comparatively rich in humus and sesquioxides. This profile can thus be considered to be a type of tropical *podsol*, the Ao humic layer from which has been removed probably by erosion or decomposition. In other types of cinnamon soils, the dark brown pan is replaced by a clay layer. These soils can only produce good crops both of annuals like vegetables and of perennials like coconuts, if liberally manured with bulky organics and artificial fertilisers. Cinnamon, however, has been grown on them with success from early Dutch times. The profile characteristics of a typical cinnamon soil are detailed below and the analytical data shown in table II.

WHITE SAND (CINNAMON SOIL)

Location	Negombo, on the west coast
Elevation	Sea level
Climate	Rainfall 90 in. (approx.); temperature 80°F. (approx.)
Geological origin ..	Probably Pleistocene plateau deposits
Mode of formation ..	Probably residual
Drainage	Excessive
Topography	Level
Vegetation	Cinnamon and coconuts

PROFILE

A. 0-60 in.	Light white sand almost pure quartz ; single grain ; loose and porous ; no concretions ; roots abundant ; acid ; horizon boundary distinct

B. 60-70 in. .. .. Dark brown sand colour increasing in intensity with depth ; otherwise as in A ; horizon boundary distinct

B2. 70-83 in. .. Blackish brown pan ; crumbles on wetting ; compact ; hard but friable ; roots absent ; acid

C. V 83 in. .. .. Light yellow sand ; water-logged

TABLE II

CINNAMON SOIL (PODSOL)

MECHANICAL ANALYSIS

	A	B1	B2
	%	%	%
Stones and gravel	—	—	—
Coarse sand	87·2	73·9	82·7
Fine sand	9·6	17·6	6·1
Silt	0·4	1·3	0·7
Clay	2·6	5·6	7·1
Loss by solution	·1	0·7	0·7
Moisture	0·1	0·9	3·1
Sticky point moisture	—	—	—
Texture index number	2·4	5·3	6·4
Soil type	Sand	Sand	Sand

CHEMICAL ANALYSIS

Loss on ignition	0·42	1·76	4·05
Organic matter	0·37	1·10	2·48
Combined water	0·05	1·66	1·57
Carbon	0·214	0·640	1·44
Nitrogen	0·028	0·047	0·047
Carbon/nitrogen ratio	9·8	13·6	30·6
Reaction—pH	4·6	4·8	4·9
Total sesquioxides	0·79	—	3·55
Total potash	0·007	—	0·049
Total phosphoric acid	·009	—	—
Total exchangeable bases (m.e. per 100 gm. soil)	1·10	1·23	2·90
Exchangeable calcium	—	—	—

CLAY ANALYSIS	B2. %
Loss on ignition	54·54
Silica (SiO_2)	46·78
Sesquioxides (R_2O_3)	46·30
Alumina (Al_2O_3)	42·10
Iron oxides (Fe_2O_3)	4·20
SiO_2/O_3 (molecular)	1·88
SiO_2/R_2O_3 (molecular)	1·77
Soil type	Lateritic to non-lateritic

A glance at table II will indicate that the A horizon is a quartz sand containing no less than 96 per cent. of this material. Its clay content is only 2·6 per cent. and its combined water content ·05 per cent. The B horizon, which is subdivided into B1 and B2, has appreciably higher percentages of this constituent. The organic matter contents of the B horizon are likewise much higher, being 0·6 and 1·4 per cent. as against 0·2 per cent. in the A layer. Nitrogen is very low throughout the profile, and the B layers have again an accumulation of this constituent. In reaction the soils are markedly acid, the acidity decreasing slightly with depth. The soil is extremely poor in potash and phosphoric acid. The total exchangeable bases are low but again show an appreciable increase with depth. A similar phenomenon is observed with regard to the total sesquioxides. It will thus be noted that there is a translocation of soil constituents from the A to the B1 and particularly B2 horizons, where they form a sort of pan. This pan sets very hard when dry, but crumbles when wet. The total lack of moisture in the surface layer during periods of drought and the tendency for water-logging during the rains will now be understood. The analysis of the clay fraction of the B2 horizon shows an alumina content of 42 per cent. and an iron oxide content of one-tenth this figure. The silica/alumina molecular ratio, *viz.*, 1·88 indicates that the soil is on the border line between the non-lateritic and lateritic types.

THE RED SANDY SOILS

The red sandy soils, also derived from the Pleistocene red earths, occur on the coastal plains, their best examples being found in the Puttalam and Marawila districts. All over

this region, however, soils of paler hues—dull red, buff, light yellow—are to be found. No. B and C horizons are discernible down to a depth of 4 ft. but in some cases a clay layer occurs at depths of 20 ft. and more. These soils, though poor in fertilising constituents, are physically ideal coconut soils, being often of great depth, well-drained and easily cultivated. A typical profile is described below and the analytical data shown in table III.

PLEISTOCENE LIGHT SANDY LOAM

Location	5 miles from Puttalam on the Puttalam-Kurunegala Road
Elevation	30 ft. (approx.)
Climate	Rainfall 46 in. (approx.); temperature 81°F. (approx.)
Geological origin	Pleistocene plateau deposits
Mode of formation	Probably residual
Drainage	Very good
Topography	Flat
Vegetation	Coconuts

PROFILE

A. 0-18 in. .. .. Brick red light sandy loam ; deep ; no marked variation with depth; loose and friable ; single grain ; root growth good ; slightly alkaline

TABLE III

MECHANICAL ANALYSIS

	Red Jurassic Loam	*Red Light Sandy Loam*
	%	%
Stones and gravel	—	—
Coarse sand	25·0	53·0
Fine sand	34·5	26·8
Silt	7·0	1·1
Clay	26·9	16·7
Loss by solution	1·7	0·6
Moisture	4·9	1·8
Sticky point moisture	21·6	10·4
Texture index number	25·1	15·4
Soil type	Loam	Light sandy loam

CHEMICAL ANALYSIS

	Red Jurassic Loam	*Red Light Sandy Loam*
	%	%
Loss on ignition	5·36	2·19
Organic matter	2·28	1·09
Combined water	3·08	1·10
Carbon	1·32	0·63
Nitrogen	0·112	0·036
Carbon/nitrogen ratio	11·81	17·14
Reaction—pH	7·1	7·5
Total potash	0·257	0·076
Total phosphoric acid	0·102	0·053
Total exchangeable bases (m.e. per 100 gm. soil) ..	15·64	1·94
Exchangeable calcium	11·14	1·55
CLAY ANALYSIS		
Loss on ignition	23·04	14·71
Silica (SiO_2)	51·86	41·90
Sesquioxides (R_2O_3)	47·70	55·30
Alumina (Al_2O_3)	26·91	37·81
Iron oxide (Fe_2O_3)	20·79	17·49
SiO_2/Al_2O_3 (molecular)	3·26	1·88
SiO_2/R_2O_3 (molecular)	2·18	1·45
Soil type	Non-lateritic	Lateritic to non-lateritic

A glance at table III would indicate that the soil is a light sandy loam containing about 80 per cent. of sand. It is poor in organic matter, nitrogen, potash, phosphoric acid and replaceable bases (of which calcium forms over 75 per cent.). Its carbon/nitrogen ratio is high. The soil is slightly alkaline in reaction. On the basis of the silica/alumina ratio of its clay complex it is, like the cinnamon soil, on the border line between the lateritic and non-lateritic types. A comparison of this soil profile with the Marawila red sand profile described elsewhere (1) will indicate the great similarity between the two.

THE JURASSIC RED LOAMS

A small outcrop of Jurassic rocks occurs at Tabbowa, near Puttalam. These rocks, which were first described by Wayland (3), give rise to a chocolate red loam of varying depth, from 3 ft. onwards. No demarcation of soil horizons is apparent. The underlying stratum is sandstone and grit in a matrix of red earth. Nodular limestone occurs in the lower strata, and

the derived soils are therefore similar in properties to the calcareous soils of the Miocene age. Agriculturally these soils are quite fertile. The area has recently been opened up under both annual and perennial crops. Tobacco, vegetables, fruits and coconuts are some of the crops cultivated. The soils are well drained and, being situated in a district of low rainfall, require irrigation during drought for successful crop growth. The soil profile characteristics are indicated below and the analytical data detailed in table III.

JURASSIC LOAM

Location ..	.. Tabbowa
Elevation ..	.. 30 ft. (approx.)
Climate ..	.. Rainfall 46 in. (approx.); temperature 81°F. (approx.)
Geological origin	.. Jurassic deposits
Mode of formation	.. Sedimentary, alluvial
Drainage ..	.. Good
Topography ..	.. Flat
Vegetation ..	.. High jungle with scrub

PROFILE

A. 0-3 ft. ..	.. Chocolate red loam uniform in texture and colour; compact but friable; irregular clod; root growth good; neutral to alkaline

An examination of the table shows that the soil is a free working loam, fairly well supplied with organic matter and nitrogen and having a carbon/nitrogen ratio of 12. The combined water content is, however, low and appears to indicate the need for irrigation during drought. In reaction the soil is neutral. Its potash and phosphoric acid percentages are quite good. The exchangeable base contents are comparatively very high, being of the same order as those of the Jaffna soils. Lime constitutes over 70 per cent. of these bases. The silica/alumina molecular ratio of the clay fraction is 3·26. The soil is thus definitely non-lateritic. Alumina constitutes 26·9 per cent. and iron oxide no less than 20·8 per cent. of the clay fraction. The high iron oxide/alumina ratio is probably the reason for the low combined water content of the soil.

THE PADDY (GLEY) SOILS

Soils suited for paddy cultivation exist in all parts of the Island. Typical paddy soils occupy the depressions between the hills and are low-lying and imperfectly drained. Any soil of sufficient body can, however, be converted into paddy soil or "aswedumised" as it is termed locally. Paddy soils vary considerably in texture from light loams and even sands to clay loams and clays. In the former case paddy cultivation is only possible because of a water-impermeable layer of clay or rock at some depth below. Root aeration is brought about in submerged paddy soils by the agencies of the micro-organic population of the soil and the dissolved oxygen of the continuously-flowing water. The alternate wetting and drying of paddy soils produces a definite type of profile, the lower horizon of which (the gley horizon) is characterised by mottlings and streaks of brown in a bluish or brownish grey matrix. These mottlings are caused by the decomposition and oxidation of plant material. The gley horizon is more marked when the soil is moist. Drainage is not altogether absent in paddy soils, as appears to be commonly believed. While paddy does grow on soils which do not permit of free drainage, all the evidence available indicates that moderate drainage is distinctly beneficial. The profile described below is one in which, despite its heavy texture, partial drainage was possible owing to the presence of an underlying gravel layer. A yield of 80 bushels of paddy per acre was obtained during a favourable season on this soil, which may thus be considered ideal for the crop. Its detailed profile and analytical characteristics are indicated below and in table IV.

PADDY (GLEY) SOILS

Location	Gannoruwa, Peradeniya
Elevation	1,760 ft. (approx.)
Climate	Rainfall 94 in. (approx.); temperature 77°F. (approx.)
Geological origin ..	Recent
Mode of formation ..	Sedimentary, alluvial
Drainage	Poor
Topography	Flat
Vegetation	Paddy

PROFILE

A.	0-4 in. ..	.. Greyish brown clay loam ; hard ; irregular columnar ; root growth good ; acid ; horizon boundary distinct
B1.	4-12 in.	.. Fawn brown clay loam ; mottled and streaked dark brown when moist ; compact ; root growth poor ; acid ; horizon boundary distinct
B2.	12-17 in.	.. Brownish yellow clay loam ; mottled ; fairly friable ; root growth poor ; acid
C1.	> 17 in. ..	.. Yellowish loam with quartz gravel; loose and friable ; root growth poor ; acid

TABLE IV

PERADENIYA PADDY SOIL PROFILE

MECHANICAL ANALYSIS

	A.	B1.	B2.	C1.
	%	%	%	%
Stones and gravel ..	0·5	2·1	4·9	20·1
Coarse sand	3·7	5·7	13·5	38·9
Fine sand	24·6	20·7	18·1	19·9
Silt	23·6	26·4	21·9	11·6
Clay	39·6	40·2	41·1	26·3
Loss by solution	2·5	1·4	1·0	0·5
Moisture	6·0	5·6	4·4	2·8
Sticky point moisture ..	36·7	35·2	31·5	23·1
Texture index number ..	38·0	38·8	39·2	24·0
Soil type	Clay loam	Clay loam	Clay loam	Loam

CHEMICAL ANALYSIS

Loss on ignition	14·62	14·54	11·66	6·63
Organic matter	4·74	4·29	2·52	1·37
Combined water ..	9·88	10·25	9·14	5·26
Carbon	2·75	2·49	1·46	0·794
Nitrogen	0·217	0·212	0·149	0·672
Carbon/nitrogen ratio ..	12·66	12·32	9·76	11·02
Reaction—pH	5·14	5·23	5·70	6·18
Total potash	0·298	—	0·253	—
Total phosphoric acid ..	0·184	—	0·219	—
Total exchangeable bases (m.e. per 100 gm. soil) ..	5·77	5·31	5·16	2·94
Exchangeable calcium ..	3·74	3·66	3·39	1·91

CLAY ANALYSIS

	A.	C1.
	%	%
Loss on ignition	28·73	21·30
Silica (SiO_2)	36·42	37·30
Sesquioxides (R_2O_3) ..	58·15	58·06
Alumina (Al_2O_3) ..	38·07	38·31
Iron oxide (Fe_2O_3) ..	20·08	19·75
SiO_2/Al_2O_3 (molecular)	1·62	1·65
SiO_2/R_2O_3 (molecular)	1·21	1·24
Soil type	Lateritic	Lateritic

On an examination of this table it will be observed that all the horizons are clay loams excepting C2 which is a loam. The stone and gravel content of the latter is 20 per cent., while that of the A and B horizons is under 2 per cent. Horizon boundaries are fairly marked when the soil is moist, but are not so apparent when it is dry. The soils are acidic in reaction, the acidity decreasing with depth from pH 5·1 to 6·2. The organic matter and nitrogen contents are high in the upper horizons, but low in the C horizon. The A and B horizons are rich in potash and phosphoric acid. The exchangeable base contents are fair in all but the C horizon and range from 5·7 mgm. equivalents in the A to 2·9 in the C horizon. Calcium constitutes about 65 per cent. of these bases. The clay analyses reveal an aluminium content of 38 per cent. and iron content of 20 per cent. The silica/alumina molecular ratio is 1·6 in both the A and C layers, indicating that the soil is of the lateritic type and probably an alluvial deposit from the surrounding hills, the top-soils of which are lateritic in nature.

SUMMARY

An account is given of the profile and analytical characteristics of the following soil groups : the lateritic gravelly soils (cabooky soils) and brown loams, the coastal white (cinnamon soils) and red sandy soils derived from Pleistocene deposits, the chocolate red loams of Jurassic origin, and the paddy(gley) soils.

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NOTES ON ORCHIDS CULTIVATED IN CEYLON

DENDROBIUM THYRSIFLORUM RCHB. f.

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AMONG the most popular epiphytal orchids introduced into Ceylon collections and grown with success for quite a number of years is the *Dendrobium thyrsiflorum*, its popularity being enhanced by the singular beauty of its blooms which add considerable charm to the general effect in the orchid house.

The plant is one of the most handsome of the Dendrobe family and is endemic in Burma. It belongs to the sub-evergreen section of the Dendrobes and closely resembles *D. densiflorum* Wall in habit. The brownish-yellow pseudo-bulbs are stiff and tall, being from twelve to thirty inches high, and have very pronounced yellow rings at the nodes. When young they carry only the smooth, fleshy dark-green leaves which are lance-shaped (6 inches long and $2\frac{1}{2}$ inches across) and found at the uppermost nodes. As the bulbs mature they shed these leaves, becoming wrinkled and woody. At this stage they are capable of flowering.

The flowers are produced invariably from the uppermost node of the naked pseudo-bulb in long drooping racemes, gracefully pendulous, and often about twelve inches long. The individual flowers are $1\frac{1}{2}$ to 2 inches across, and have delicate white petals and sepals, sometimes flushed with pink, and broad golden-orange pubescent lips.

Well-established plants may produce as many as twelve floral spikes at one and the same time and are most spectacular and eminently suited for exhibition purposes. The blooms, however, last generally for a few days only, and not more than ten days under the most favourable conditions.

Dendrobium thyrsiflorum Rchb. f.

Culture.—Being a fairly hardy plant it will readily adapt itself to any position in a pot, basket or on wood. Although it is known to thrive fairly well in most parts of Ceylon, it blooms less freely at low altitudes. This could be remedied to some extent by increasing the atmospheric humidity in the orchid house during hot and dry spells.

It should be noted that well-grown, healthy plants should not be transplanted or disturbed in any way unless they have overgrown their pots. An excellent rooting medium in which to start a plant can be made up with equal parts of charcoal and brick-bats. On the appearance of new roots at the base of the plant, a small quantity of seasoned coconut husk, flaky leaves and a few pieces of crushed bone may be distributed among the compost, taking care not to disturb or injure the new and delicate root growth.

Propagation is easily effected by the division of a clump, each part having an active lead. The division of clumps should be made only when new leads are formed, after the flowering season.

To encourage flowering it is essential that the plants should get a decided rest on the completion of a season's growth, so as to ensure the ripening of the pseudo-bulbs. When the foliage of the plants appears to be less succulent and the pseudo-bulbs assume the appearance of maturity, plants may be exposed to rain or given copious supplies of water, for about a week. Following this, they should be exposed to dry atmospheric conditions, under shelter, and gradually the supply of water should be reduced to an afternoon syringe. This treatment will accelerate the production of flowers.

The old, naked, pseudo-bulbs are capable of flowering for two or more years and should not be removed until signs of decay are visible at the base of the bulb.

DEPARTMENTAL NOTES

CULTIVATION OF CLOVES IN KANDY DISTRICT

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ACTING PROPAGANDA OFFICER

CLOVES (*Eugenia aromatica*) were first planted in our villages about fifty years ago. In 1883 clove plants were distributed to headmen throughout the Kandy District by the then Government Agent of Kandy, Mr. J. F. Dickson. The plants were probably supplied from the Royal Botanic Gardens, Peradeniya. Of these, 85 trees are still flourishing in Harispattu.

During the period 1928-1933 clove cultivation received the special attention of the writer as Agricultural Instructor, Katugastota Range. A census of trees in that area revealed that there were, at the end of 1933, 1086 clove trees, which number included some five hundred trees less than five years old. Since then many more trees have been planted.

Cloves have not been grown as a plantation crop in Ceylon. Trees in the Kandy District are scattered, while in the Arambepola-Alawatugoda area there are some groves of a few trees each. It has been said that in this area there are some of the finest clove trees in the world. One particular tree is known to have given, occasionally, during the last twenty-five years, two hundred pounds of dried cloves in a single crop. The average annual crop from a well-established tree is 10 to 12 pounds.

Enquiries regarding the cultivation of cloves have been received recently from prospective growers in various parts of the Island and in view of the increase in the number of trees planted recently it is the author's opinion that the output of cloves will increase considerably.

Cloves are used in Ceylon as a spice and condiment, medicinally and as one ingredient of a "chew of betel." The annual local consumption has been estimated as 1,000 cwt. This quantity is fully met by local production and a surplus is available for export. India, where the consumption of cloves is much larger, imports about 70,000 cwt. of cloves annually, chiefly from Zanzibar. Ceylon cloves have the reputation of being better than those of Zanzibar. There seems, therefore, to be a market for an increased output of cloves both in India and in the West because of the good quality of Ceylon cloves.

The cloves of commerce (*Karambu*, Sinh.) are the dried unexpanded flower buds which are harvested in January-February in Kandy District. The buds are green at first, becoming yellowish and soon assuming a pale red colour, at which stage they are plucked and dried in the sun for a few days until they become hard and dark brown in colour. Prices for many years ranged between 80 cents and Re. 1·25 per lb. and at times, owing to short crops, prices went up to Re. 1·50 per lb. They fell during the depression but have improved in the last few years and are now 45 cents to 55 cents per lb.

The clove is a slow growing tree which does best on a deep, rich, well-drained soil and takes about seven or eight years to come into bearing. From then the yield increases and after about twenty years crops vary from 20 to 40 lb. of green or 5 to 10 lb. of dried cloves. It has been observed that crops vary considerably from year to year even in full-grown trees. Records show that the crop from one tree about fifty years old has varied from 10 to 150 lb., sometimes with an interval of years without any crop. One tree gave in 1929 the extra-ordinary crop of 240 lb. of dried cloves and this was followed by no crop until 1936 when 86 lb. were gathered.

The clove tree is commonly propagated from seed and can also be propagated by layering. Seeds are planted in boxes or bamboo pots. Great care is necessary with the young plants which should be well shaded and regularly watered. As the plants grow they should be gradually exposed to the sun to harden them. When plants are about 12 inches high, at which stage they are about 9 or 10 months old, they are

transplanted, care being necessary to see that the tap root is kept straight. Transplanting is best done in wet weather. If dry weather sets in, the plants should be watered regularly until they begin to throw out new leaves. Cloves have given the best results when planted in pits 3 ft. × 3 ft. × 3 ft. filled with top-soil mixed with well-decomposed farmyard manure. Light shade is required until the young trees are well established. A good distance to plant is 25 feet apart. Though ordinarily it takes about 7 or 8 years to produce a first crop, with good cultivation and grown under ideal conditions, cloves have commenced to yield in the fifth year in Harispattu.

In harvesting care should be taken not to damage the small branches when picking the clusters of buds. Damage to branches may result in the absence of a crop for the following two or three years. The clusters of buds should be picked by hand or by means of hooked sticks. The buds must be in the right stage of development or the quality of the dried cloves will be unsatisfactory.

SELECTED ARTICLES

THE PERFORMANCE OF IMPORTED CLONES IN CEYLON – I*

INTRODUCTION

FOR our knowledge of the performance of the various high-yielding clones which have been imported into Ceylon we have hitherto been almost exclusively dependent on data published in the countries of origin, and with the object of keeping the Ceylon planter in touch with the latest information regarding the clones established in his field or nursery such data have, from time to time, been collated and published in the *Quarterly Circular*. Doubts are often expressed, however, as to the extent to which results obtained in other countries will be applicable to the diverse conditions of climate, elevation and, in a smaller degree, soil under which rubber is grown in Ceylon, and the time when these clones became tapped on our own estates has been eagerly awaited. There are as yet in Ceylon no large areas planted exclusively with imported clones which have reached the stage of commercial tapping, and for such figures we are still dependent on Malaya and the Netherlands East Indies. Test-tapping data of small groups of trees are, however, beginning to accumulate, and although such records are of a somewhat fragmentary nature they are considered to be of sufficient interest to merit publication at the present juncture. The following notes are intended as the first of a series of annual reviews, which will run parallel with notes on clones of local origin.

It is convenient to consider the available information under two headings : (1) Growth and (2) Yield.

GROWTH

It has been observed that not only do clones show considerable variation amongst themselves in respect of vigour of growth, but that there is a differential response to environmental conditions, *i.e.*, a clone which is vigorous in one locality may be less satisfactory in another. In planning replanting or budding programmes it is clearly important to know which clones are likely to show satisfactory development under the specific conditions in which they are to be grown, for it is obviously undesirable to select a clone which has a very high potential yield but is unsuited to the locality on account of growth or other secondary characteristic.

* By R. K. S. Murray, Botanist and Mycologist in the combined Second and Third Quarterly Circulars for 1936, Rubber Research Scheme (Ceylon).

Our knowledge of the regional suitability of the various imported clones is very imperfect and, being based mainly on general observations, is of a somewhat empirical nature. We are in possession, however, of two series of comparative measurements which illustrate the rate of development of some of the more important clones under conditions of relatively low and high rainfall respectively. The figures are given in tables I and II and are commented on in the notes on individual clones. It should be mentioned that the girths given in table I are strictly comparable, being derived from replicated plots whereas those in table II are taken from contiguous fields, some of which are more favourably situated than others. Clones A.V.R.O.S. 49 and B.D. 5, in particular, suffer from being planted in rather exposed areas.

TABLE I

Girth Measurements at Iriyagama Division, Experiment Station, Peradeniya

Average Annual Rainfall : 93·3 ins. Elevation : 1,550 feet
Planted budded stumps : October, 1929
Seedlings as basket plants : October, 1929
Means of 60 trees in each clone

Clone	Girth at 3 feet in Nov., 1933	Aug., 1934	Sept., 1935
Tjirandji 1	11·62 ins.	14·30 ins.	17·90 ins.
Tjirandji 16	10·36 ,,	13·26 ,,	16·31 ,,
A.V.R.O.S. 49	10·45 ,,	12·60 ,,	15·54 ,,
A.V.R.O.S. 50	9·91 ,,	11·66 ,,	14·59 ,,
Bodjong Datar 5	9·91 ,,	11·39 ,,	14·42 ,,
Tjirandji 8	9·47 ,,	11·66 ,,	14·24 ,,
Heneratgoda 2	9·51 ,,	11·33 ,,	14·12 ,,
Sungei Reko 9	9·83 ,,	11·55 ,,	13·98 ,,
Seedlings	11·02 ,,	13·55 ,,	17·02 ,,

TABLE II

Girth Measurements on Estate A, Ratnapura District (made at 3 feet from ground)

Average Annual Rainfall : 200 ins. Elevation : 400 feet
1927 stocks budded : 1931–32

Clone	No. of trees measured	Percentage in Classes in June, 1936 Under 10″	10″-15″	15″-18″	Over 18″
Tjirandji 1 ..	3,337	14·3	10·1	26·7	48·9
Bodjong Datar 10 ..	555	12·4	23·1	30·1	34·4
A.V.R.O.S. 50 ..	3,161	14·3	24·9	38·3	22·5
A.V.R.O.S. 49 ..	2,362	15·2	28·0	33·6	23·2
Bodjong Datar 5 ..	1,988	26·2	37·5	27·1	9·2
1928 stocks budded : 1932					
A.V.R.O.S. 256 ..	806	22·2	69·4	8·4	—
Tjirandji 16 ..	648	30·9	59·4	9·4	0·3

YIELD

The yield records available up to the end of 1935 are summarised in Table III. The procedure of test-tapping on the different estates is somewhat variable, the trees having been tapped in some cases for the whole year and in others for only a few months, and in order to bring the figures to a common basis they have all been calculated as a yield in lb. dry rubber per tree for a year of 130 tappings on a half-spiral system. In some cases the recording is done on the estate while in others the rubber is sent regularly to these laboratories to be weighed.

At first sight it would appear that the variation in yield within a clone is unduly large, the figure for one estate being sometimes as much as twice the yield of trees of the same age on another estate. A partial explanation is to be found in the average girths given in column 4, but there are other reasons which cannot be mentioned in detail in an article of this nature. For example, all the yields on the Experiment Station, Peradeniya, are relatively low, and this is only to be expected in view of the dry climate and high elevation. The figure of 130 tappings per annum, also, while considered fair for the wetter districts, is rather low for Peradeniya where the smaller yield per tapping is partly compensated by the larger number of tapping days.

Comparison of these figures with the yields of the original buddings of the same clones in the countries of origin is not possible in all cases as test-tapping was not always started at these immature ages. For most clones, however, records of " second generation " buddings are available, and on the whole it may be said that the Ceylon yields compare quite favourably with those in other countries when girth as well as age is taken into consideration.

On some estates there is an interesting comparison between the buddings and ordinary unselected seedlings planted in the same area, and the comparison is always greatly in favour of the former. The following example may be quoted :—

On Estate E a clearing was planted with seed in 1927. Alternate plants were budded in 1929, and the yields of 11 Tjirandji 1 buddings and the inter-planted seedlings for the period November, 1934 to December, 1935 were as follows :

	Average Girth in December, 1935	No. of Tappings	Yield per tree
Tjirandji 1	25 inches	133	6·6 lb.
Seedlings	31 inches	133	2·3 lb.

The yield of the buddings was therefore nearly three times that of the seedlings, despite the fact that the latter were two years older and 6 inches larger in girth.

NOTES ON INDIVIDUAL CLONES

The following notes are based not only on the yields given in Table III, but also on records which are coming to hand during 1936.

Tjirandji.—The growth of this clone is exceptionally vigorous under all recorded conditions, and in all collections of imported clones which have come under the writer's observation Tjirandji 1 heads the list. Table I shows that in the relatively dry climate of Peradeniya the buddings of this clone are larger than seedlings planted as basket plants at the same time.

The yield records, also, are very satisfactory and show that this clone attains a high yield at an early age. Results from other countries indicate that the clone is susceptible to periods of drought, the yield falling off in a marked degree. Experience in the drier districts of Ceylon is insufficient to judge to what extent this will be balanced by the exceptionally high yields in the wetter months, but in the meantime it would be unwise to use this clone extensively in such districts as Uva and Matale.

The most important defect of this clone is susceptibility to wind damage on account of the heavy crown, but it would appear that the steady winds which are experienced on our exposed hill slopes are less damaging than the violent cyclonic storms which periodically occur in the flatter lands in other countries.

Tjirandji 16.—This clone is usually found to be a weak grower in the wetter districts, but it occupies second place in the Peradeniya collection given in Table I. Judged by vigour of growth it would appear to be more suited to the drier than to the wetter zones. The trees are rather susceptible to attacks of Oidium owing to a late wintering habit.

Bodjong Datar 5.—Early growth is rapid, but it is usually not until about the fourth year that the plant begins to form a crown. While the tree consists of a single main stem with a number of small, useless lateral branches the girth increase is very slow, and the clone is accordingly one of the last to attain tappable size. The formation of a crown can be artificially induced by pollarding at a height of about 8 feet as soon as the bark is quite brown at that height. The cut should be made in an internode and three shoots allowed to develop at well-spaced intervals. The growth of the clone seems to be remarkably uniform under different environmental conditions.

The yields so far obtained in Ceylon show promise but are not outstandingly high, and in view of the exceptionally high yields obtained from older buddings

in Java it would appear that the clone is late maturing. B.D. 5 is probably well suited to the drier districts.

Bodjong Datar 10.—Growth is rapid and the early yields encouraging, but the clone is no longer recommended on account of susceptibility to Brown Bast, unevenness of the renewed panel and liability to wind damage.

Djasinga 1.—This is one of the older Java clones which is now generally considered to be only a moderate performer. The growth is relatively slow, but the yields obtained on Estate B (Table III) are very high.

A.V.R.O.S. 49.*—Compared with the figures published in other countries the growth and early yields of this clone are rather disappointing. There is some evidence that A.V.R.O.S. 49 may be better suited to the drier districts.

A.V.R.O.S. 50.—This clone is now recognised in other countries as being of only moderate merit, and experience in Ceylon confirms this view.

A.V.R.O.S. 80.—This clone has not been extensively used in Ceylon, but the only record of yield available is very encouraging. Experience in Sumatra, however, shows that the buddings never attain an exceptionally high yield.

Prang Besar 23.—Growth is rather weak and early yields are not specially promising.

Prang Besar 25.—The buddings show vigorous development on a rather poor lateritic soil at the Experiment Station, Nivitigalakele, and early yields from two estates are very high. The performance of this clone in Ceylon and Malaya indicates that it will probably be of value for replanting poor land.

*Since these notes were written information has been received that the latex from buddings of this clone has an objectionable tendency to pre-coagulation.

TABLE III

Clone	Where tapped	No. of trees	Average girth at 3 ft. in July, 1935 in ins.	Calculated yield in lb. per tree for a year of 130 tappings at ages of (years) 4	4½	5	5½	6	6½	7	7½
Tjirandji 1 ..	Estate (A)	8	19·7				6·3				
	,, (B)	39	25·4						9·8		
	,, (C)	3	23·2	3·0		4·6					
	,, (D)	6	18·1				4·3				
	,, (E)	11	23·5					6·4			
	,, (F)	10	21·5	2·3		3·3					
	Experiment Station, Peradeniya	7	19·1				3·0				
Tjirandji 16 ..	Estate (A)	2	17·0				4·7				
	,, (B)	20	22·5						6·2		
	Experiment Station, Peradeniya	6	17·5				2·8				
Bodjong Datar 5 ..	Estate (A)	2	17·5				3·6				
	,, (B)	47	25·0							8·7	
	Experiment Station, Peradeniya	2	18·8				2·8				
Bodjong Datar 10 ..	Estate (A)	6	17·6				5·3				
	Experiment Station, Peradeniya	7	17·8				2·5				
Djasinga 1 ..	Estate (B)	10	24·0					8·7			
	,, (D)	6	16·0				2·9				
	,, (G)	11	22·5				4·2				
A.V.R.O.S. 49 ..	Estate (A)	2	18·7				3·4				
	,, (B)	32	25·0							5·6	
	,, (G)	2	22·2				4·1				
	Experiment Station, Peradeniya	3	17·1				2·2				
A.V.R.O.S. 50 ..	Estate (A)	3	18·5				3·4				
	,, (B)	37	25·0							6·3	
A.V.R.O.S. 80 ..	Estate (B)	14	24·5							9·3	
Prang Besar 23	Estate (G)	2	21·5			3·7					
	,, (H)	3	18·5			3·3					
Prang Besar 25	Estate (G)	3	21·2			5·1					
	,, (H)	3	20·7			4·8					

THE RATIONAL MANURING OF COLONIAL PLANTATIONS *

" The soil must be renewed, which, often washed,
Loses its treasure of salubrious salts,
And disappoints the roots."

Cowper : The Task

THE average planter becomes interested in manuring when high crop prices indicate that fertilizer treatment is likely to prove a profitable venture. He is then inclined to manure without considering whether the particular treatment he adopts is the most economic one or not. All he cares is that it pays him to manure. But when crop prices are low, his first aim is to cut the cost of production, and very often one of his earliest economies is to give the " cease fire " to all manurial programmes.

Now, planting may not be an exact science, but manuring is, or should be. The sole object of manuring at any time is to produce crops more profitably than could be done without it, and it is surely up to the planter to know not merely when it will obviously pay to treat his crops with any complete fertiliser mixture, but rather the precise influence on yield, however slight, that he may expect from each particular nutrient element in order that he may determine the exact amount of profit, if any, to be gained over a varying range of prices of crop and fertiliser alike.

This is not, as many think, a matter for the expert, but a matter for the planter to determine on his own land. If he needs expert advice he can readily obtain that gratis from Government and other institutions, whose special duty it is to help him. With a sound knowledge of the basic principles of manuring, which can be acquired without much difficulty, and a determination to stick to the Biblical advice to " prove all things ; hold fast that which is good," he need have no fear of throwing away money by injudicious manuring, or of losing any opportunity to make a profit where that is possible. The degree of economic response to manurial treatment is something which can be ascertained only on a substantial basis of fact, and this article outlines several of the elementary but fundamental principles which must be observed.

LIMITING FACTORS TO GROWTH

For satisfactory plant growth it is essential that there should be an adequate supply of food, water, light, a suitable temperature, root room and

*By E. J. McNaughton, B.Sc., in *The Crown Colonist*, November, 1936.

an absence of injurious salts from the soil. If any one of these factors is deficient, growth will be correspondingly limited, just as the strength of a chain depends upon the strength of its weakest link.

It is imperative that the planter should thoroughly understand this law of growth before embarking on any manurial scheme. Suppose, for example, that there is only enough water in a soil to grow three tons per acre of a crop which elsewhere yields much more, then no amount of manuring can raise the yield until an adequate water supply is assured ; yet it is surprising how many planters fail to appreciate this point and, after expending large sums of money on manuring, give up in disgust, convinced that the yield of their crops cannot be increased by the use of fertilisers.

Where plantations are on low-lying land, yields are commonly limited by a high water table, and drainage is essential prior to manuring. If the water supply is deficient, irrigation, or some other remedial measure, is the first step towards improved yields. It is only when all other growth factors are maintained at a satisfactory level that it is possible to increase crop yields by the addition of nutrients to the soil.

Of the food materials required by plants, only three are commonly lacking in the soil. These are nitrogen, phosphoric acid and potash. Nitrogen is the chief element concerned with the actual growth of the plant, and should be applied in all cases where production of luxuriant foliage is desired. It is commonly deficient in tropical soils owing to the rapid decay of the vegetable matter from which it is derived in nature, and the heavy leaching consequent upon high rainfall. Phosphoric acid, which promotes root formation and is an essential constituent of every living cell, does not always exist in sufficient quantities for satisfactory growth and often must be applied to the soil. Potash is less commonly deficient, but, as it is important in wood and starch formation and acts to increase the vigour of plants and strengthen them against disease, care must be taken to ensure that sufficient is available for plant use, particularly in the case of leguminous crops.

The law of limiting factors holds good with regard to the selection of nutrients. Granted that a crop is suffering only from malnutrition and that this is due to lack of the element nitrogen, it would be useless to manure with fertilisers containing only phosphoric acid or potash in the hope of increasing yield. Nitrogen supply, in this instance, is the dominant plant requirement, and growth will improve according as its deficiency is made good. If, for example, all other factors are sufficiently abundant to give a maximum yield of ten tons per acre while there is enough potash for only eight tons, enough phosphoric acid for seven tons and just sufficient nitrogen for four tons, then no improvement at all can be expected until nitrogen has been supplied. The addition of nitrogen alone, however, could not bring the yield above seven tons when the absence of phosphoric acid will determine crop size. Thereafter it becomes necessary to add phosphate with nitrogen, when the yield will rise to

eight tons. The three elements are then required to reach the maximum. Here we have three links of varying degrees of weakness in the growth chain, and it is necessary to strengthen these proportionately.

It will be evident that by the use of nitrogen alone in the above instance, yields can be raised from four to seven tons per acre, or by three tons, by use of nitrogen alone ; whereas fertilisers containing nitrogen, phosphoric acid and potash must be used to bring it up the remaining three, from seven to ten tons per acre. Since the yield would not exceed four tons without manuring, the first gain of three tons may justly be attributed to the action of nitrogen alone, and the final three tons to the combined action of nitrogen, phosphate and potash. Suppose now that the nitrogen treatment costs £1, and the complete fertiliser twice as much ; then, with a crop value of 10*s.* per ton, the planter would make a profit of 10*s.* on the first three tons increase, but a loss of 10*s.* on the second. Clearly, it would not always pay the planter to manure for maximum yields, whereas moderate manuring might nevertheless be profitable. When a good crop response is obtained from treatment, it could even pay a planter to manure at a loss in certain cases, to prevent a still greater loss. Many tea planters, for example, continue to treat their bushes in order to prevent vegetative deterioration, although the market price for the crop may be definitely unremunerative.

When the planter has assured himself that defective growth of his crops is not due to the effect of disease or any other limiting factor, he may then consider malnutrition as a possible cause. Signs of improved growth in even a small part of a poorly growing area, where soils and climatic conditions seem to be uniform, may indicate that the crops are in a starved condition. It may be, for example, that plants grow more vigorously and that foliage is of a richer, darker green in the neighbourhood of coolie lines, or where cattle dung has been deposited, or a dead animal has been buried ; in other words where extra plant nutrients are available. This can be taken as a definite indication that response is to be gained from suitable manurial treatment. Again, it might be found that growth was poor on a particular site where heavy crops had been taken prior to planting, the land obviously having been depleted of some of its resources.

When growth is slow and the leaves are small and yellowish in colour, the probability is that the plants are suffering from lack of nitrogen. Delayed ripening, stunted roots, and a greyish appearance of the foliage are symptomatic of phosphate deficiency. Lack of potash may be shown by failure of cereals and fruits to mature properly, and by a greyish and mottled appearance of the foliage.

INFLUENCE OF SOIL AND CROP

Every planter knows that his crops vary in yield according to soil type, but he does not always correlate that knowledge with his selection of fertilisers.

Virgin soils require no treatment for several years, but under tropical conditions their reserves soon become depleted, and declining growth rate after several years demonstrates that food supply is running short, when manuring is called for. Peaty soils which consist of decaying vegetable matter contain abundant nitrogen, and it is usually unnecessary to include that element in the fertiliser dressing. On the other hand, they tend to be acid, and the addition of lime to neutralise and so "sweeten" the soil is advisable, with phosphate and potash where fruiting is poor. Clay soils usually contain ample potash, but lack nitrogen and phosphoric acid. Sandy soils are deficient in the three main plant foods, which should therefore be added to improve growth.

Different crops remove different quantities and proportions of nutrient from the soil. Thus, a sugar-cane crop will take away nitrogen, phosphoric acid and potash roughly in the proportions 1 : 1 : 4, and a tea crop 5 : 1 : 2. The rate of removal depends partly on the bulk of the material harvested. A fair tobacco crop, for example, will remove 90 lb. of nitrogen per acre, (equivalent in fertiliser value to 4 cwt. of sulphate of ammonia), or about two to three times as much as tea. It does not follow, however, that fertiliser dressings designed to increase yield should contain the elements in the proportions removed. A peaty soil, for instance, may contain more than enough nitrogen for optimal growth, when its inclusion in a fertiliser mixture would not affect yield, although heavy quantities may be taken away by the crop. Obviously, different fertilisers must be designed to suit each set of circumstances, but the point is that, if no replacement is made, the soil will eventually become exhausted. Even if the planter is content with his crops, and does not intend to manure for higher yields, he should at least replace nutrients equivalent to those taken away in the harvested crop in order to maintain the fertility of the soil.

MANURES TO USE

The nutrient elements can most conveniently be applied to the soil in the form of certain chemical substances, usually spoken of as "artificial fertilisers," or as "organic manures" of animal or vegetable origin. The value of a fertiliser largely depends upon the amount of each nutrient element that it contains and upon its solubility, and therefore availability, to the plant. Sulphate of ammonia, for example, which is the standard source of nitrogen, contains, like other fertilisers, several chemical elements not used by the plant, but its value as a fertiliser depends entirely upon its nitrogen content, generally guaranteed as 20·6 per cent. Superphosphate, which contains 18 per cent. or more of phosphoric acid, is the standard source of this nutrient, while sulphate of potash is the standard fertiliser for the supply of potash, of which it contains 48 per cent. There are numerous other sources of these plant nutrients. Nitrate of soda and calcium cyanamide, for example, contain 15 per cent. and 18 per cent. of nitrogen respectively. Rock phosphate

may supply 25 per cent. to 35 per cent. of phosphoric acid in an insoluble form, while basic slag also supplies this element and lime as well. Muriate of potash and kainit contain 50 per cent. and about 14 per cent. of potash respectively. By mixing suitable fertilisers, compounds containing two or three elements can be prepared ; but modern synthetic fertilisers are now manufactured which supply different proportions of nitrogen, phosphoric acid and potash, designed to meet the varying needs of plants growing on different soil types. These are so concentrated that they carry about twice as much plant food per ton as ordinary mixtures, which, from the planter's point of view, represents a great saving in freight, and labour in spreading and handling. Organic manures such as farmyard manure, bean, rape, cotton, castor and other cakes, fish and meat guano, dried blood, horn and hoof meal, shoddy and numerous other substances contain varying amounts, usually much less than artificials, of plant nutrients. The special value of organic manures is that, in addition to supplying nutrients, they improve the texture of the soil and its content of useful bacteria, but they are usually expensive sources of plant nutrients.

The best agricultural practice is to use as much home produced farmyard manure or natural organic matter as possible—or in the tropics, where these are rarely obtained in any quantity, to cultivate leguminous cover crops which enrich the soil with nitrogen—and to supplement these where necessary with artificial fertilisers.

Apart from subsidiary effects, manures are commonly evaluated in terms of the amounts of available nutrients which they contain, and unless the planter is familiar with the method of evaluation he may easily pay too much for his plant foods. He might, for example, purchase a cake manure at, say, £5 per ton, thinking this cheaper than sulphate of ammonia at £7 per ton ; but the latter contains 20 per cent. of the element nitrogen and the former about 5 per cent. He would, therefore, be paying 140*s.* for 20 per cent. of nitrogen in one ton of sulphate of ammonia or 7*s.* (140 ÷ 20) per 1 per cent. of nitrogen in one ton, whereas the nitrogen in the cake would cost him 20*s.* (100 ÷ 5) per unit. Even allowing for the small quantities of phosphoric acid and potash contained in the cake, sulphate of ammonia at the above price would be a very much cheaper source of nitrogen.

In a similar way other fertilisers can be evaluated in terms of the standard artificials, sulphate of ammonia, superphosphate and sulphate of potash. All that is required is to determine the " unit value " of each manurial element contained—the cost of 1 per cent. in 1 ton—by dividing the price per ton by the guaranteed analysis.

Few planters will be prepared to conduct an extensive manurial scheme without exact evidence, particularly as it is so easy to throw away money by injudicious treatment.

Chemical and mechanical analyses of the soil are poor guides when it comes to deciding a manurial programme. It is only when the exact response of a

crop as determined by field experiment has been obtained on an area, the chemical and mechanical analyses of which are known, that the method becomes of real use : for then it is possible to apply the satisfactory treatment to other areas having a corresponding soil analysis.

Field experiment is the royal road to the determination of manurial response, and every planter interested should arrange for satisfactory trials to be made prior to big-scale manuring. If, however, crop and fertiliser prices are such that it would obviously pay to fertilise, then the planter should certainly proceed with the use of a mixture which he knows will increase yield profitably, pending results of a trial which will definitely inform him as to the most suitable and economic fertilisers to use. In every case accurate trials are desirable, and the planter should seek the advice of local agricultural authorities as to the proper method of laying out and conducting such experiments. Simple rule of thumb trials may do more harm than good by providing misleading data. Accuracy should be the keynote of every trial, and nothing should be left to chance in the difficult task of making money out of the soil.

FRUIT FLY—CERATITIS CAPITATAY

BAITING, TRAPPING AND LURING EXPERIMENTS

DURING the past summer and autumn a series of baiting, trapping and luring experiments have been carried out by the Entomological Branch, with a view to testing new and improved baits, traps and lures.

Baiting.—These baiting tests were made in breeding cages, using 50 flies in each, with the poisons arsenate of lead and sodium fluosilicate at varying strengths. The attractants in combination with the poisons were molasses and white sugar.

It was soon demonstrated that the molasses inhibited the poisoning effect of both poisons. This is a chemical reaction which we do not attempt to explain. Dr. Ripley, Department of Agriculture, South Africa, in reporting upon this fact, states in explanation that when treacle is used in combination with sodium fluosilicate, the lime in the treacle reacts chemically with the fluosilicate, producing compounds of much lower toxicity, but that it is not yet understood why it also lowers the toxicity of arsenate of lead. The same appears to apply to the use of molasses, as has definitely been proved in our experiments. Replacing the molasses by sugar, the toxic powers of these two poisons do not appear to be affected.

The use of molasses in the local arsenate of lead foliage bait accounts for the comparatively slow poisoning action on the fruit fly. This bait takes from 8 to 10 days to give 100 per cent. kill. It is probable that many of the flies continue to lay a proportion of their eggs after taking the bait. This bait, however, when applied systematically and regularly once a week, has considerably helped in the control of fruit fly. In the experiments just completed it has been definitely proved that sodium fluosilicate, when used with sugar, is more highly toxic to the fruit fly than arsenate of lead and sugar. The flies readily partake of the bait containing this poison and quickly die.

The following formula was used with great success :—

Test 1.—

Sodium fluosilicate	1 oz.
White Sugar	2½ lb.
Water	4 gallons

This resulted in 100 per cent. kill of flies in 46 hours.

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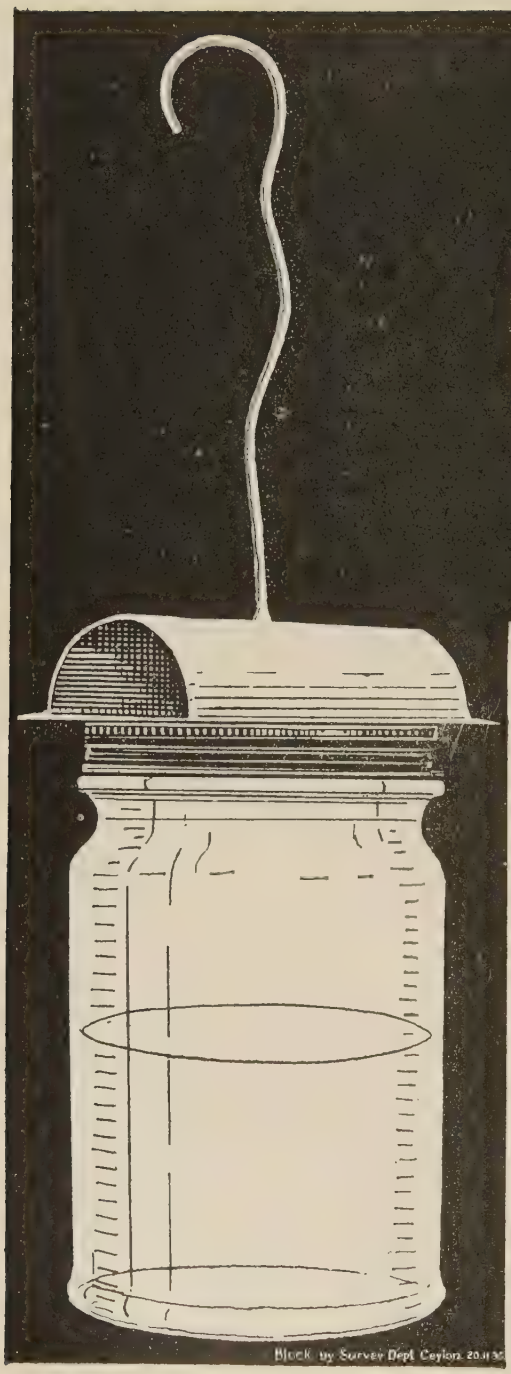
* By L. J. Newman, F.R.E.S., Government Entomologist and C. F. Jenkins, B.A., Assistant Entomologist, in the *Journal of the Department of Agriculture, Western Australia,* Vol. 13, No. 3, September, 1936.



View of under-side of lid showing hole cut for admittance of fly

BROWN'S FRUIT FLY TRAP

Note.—In this case the bottle was whitened for photographic purposes. A clear glass screw-topped bottle should be used

Test 2.—Formula :

Sodium fluosilicate	1 oz.
Molasses	4 lb.
Water	4 gallons

It will be noted that the only difference was the substitution of the molasses for the sugar. This took 168 hours, or seven days, to give 100 per cent. kill of flies, against 46 hours when white sugar was used.

Following this definite proof of the inhibiting effect of molasses on the toxicity of sodium fluosilicate, similar tests were conducted with arsenate of lead.

Test 3.—Formula :

Powdered Arsenate of Lead	5 oz.
White Sugar	4 lb.
Water	4 gallons

This gave a 100 per cent. kill in 120 hours or $5\frac{1}{4}$ days.

Test 4.—The same formula, substituting molasses for the white sugar :

Powdered Arsenate of Lead	5 oz.
Molasses	4 lb.
Water	4 gallons

Result.—100 per cent. kill of flies in 216 hours, or nine days—nearly twice long as when white sugar was used.

This demonstrated that molasses has the same effect of reducing the toxicity of arsenate of lead as it had on the sodium fluosilicate.

Test 5.—Formula :

Powdered Arsenate of Lead	3 oz.
White Sugar	4 lb.
Water	4 gallons

This resulted in 100 per cent. death of flies in 144 hours or six days. This was only 16 hours more than when 5 oz. of the arsenate of lead was used with sugar.

This would seem to indicate that there is not sufficient advantage gained by the increase of the arsenate of lead content above the 3 oz. to the four gallons of water.

A further test was made with the sodium fluosilicate and molasses, doubling the amount of the poison.

Formula :

Sodium fluosilicate	2 oz.
Molasses	4 lb.
Water	4 gallons

This resulted in 100 per cent. kill of flies in 168 hours or seven days, being five days longer than when 1 oz. of the sodium fluosilicate was used with $2\frac{1}{2}$ lb. of white sugar to 4 gallons of water.

In carrying out these baiting experiments, all tests were duplicated.

To determine whether sodium fluosilicate would in any way injure trees or plants, a series of spraying trials were undertaken using double strength. This spray was applied to all kinds of fruit trees, shrubs and flowers, with negative effect, no sign of burning being noticeable. The bait was also found to remain moist and sticky for several days.

As the result of these series of experiments, the following foliage bait is advised :—

Formula :		
Sodium fluosilicate	.. .. ..	1 oz.
Sugar	.. .. ..	2½ lb.
Water	.. .. ..	4 gallons

The cost of this bait should not exceed 4*d*. per gallon. Allowing that each tree carrying fruit will require ½ pint of the bait, 1 gallon should be sufficient for 16 trees. The bait must be applied at least once every seven days and renewed when washed off by heavy rain.

Foliage baiting of deciduous fruit trees should be commenced when fruit is within seven weeks of ripening and continued until fruit is picked. Baiting of citrus trees carrying fruit should commence by the 1st of September and continue to the end of May. Advantage should also be taken of any fine period during the winter to apply the bait, thus poisoning the over-wintering flies.

It is important to refrain from baiting any fruit trees during the period of blossoming, as by so doing there is great danger of poisoning bees and other useful wasps, etc., which frequent the flowers. The fruit fly is essentially a fruit-infesting insect and does not attack the flowers.

The alternative formula, if sodium fluosilicate is for any reason not procurable, is the following :—

Powder Arsenate of Lead	.. ..	3 oz.
White Sugar	.. .. ..	2½ lb.
Water	.. .. ..	4 gallons

The juice of any fruit in season may be added.

In applying this bait it is essential to keep it well agitated as the poison has a tendency to precipitate to the bottom of the spray pump or bucket. The spray should not be applied too finely, a coarse nozzle being used so that it falls on to the leaves in the form of small rain drops. Apply to certain patches of foliage on two to four sides of the tree, avoiding the fruit.

Trapping.—Four types of covered traps were used namely Brown's "Slip On," new type, "Slip On," old type, and Green's new type. The "Slip On" old type was used as the control. The period of the test was from 8th April to the end of May.

The results were as follows :

Brown's captured 2,640 fruit flies
" Slip On " new type—2,559 fruit flies
" Slip On " old type—2,110 fruit flies
Green's new type—1,959 fruit flies

From these figures it will be seen that there is not much to choose between the first three traps, Brown's trap, which is not a proprietary trap, capturing the highest number.

Brown's trap is simple to construct. It is made with little labour, from any metal screw-topped glass jar, of about half a pint capacity. A hole about one inch in diameter is stamped or cut out in the centre of the lid. Over this hole is soldered a piece of galvanised iron in the shape of a small hood. To the hood is attached a piece of pliable wire, whereby the trap is suspended in the tree.

It is necessary that all traps shall be covered, as this reduces the evaporation of the lure, prevents flooding by rain and spilling over during windy weather. Covered traps can be used in citrus trees through the winter months, thus capturing the over-wintering flies.

In small orchards up to 200 trees, trapping is advised. At least two traps per tree should be used, the more the better. The traps should be placed about half way up the trees. During the months of November to March inclusive, they should be hung in a shady position and from April to October in sunny aspect.

In orchards of over two acres, it is recognised that the trapping method cannot be economically applied, foliage baiting being cheaper and more efficient. Traps can be used in large orchards as indicators, as to whether the fruit flies are present, thus acting as a guide for spraying.

Lures.—Beeco, clensel and Bordeaux mixture were the lures tested. Clensel was found to be the most effective and is therefore preferred. Beeco was also good. Bordeaux mixture proved somewhat attractive, but could not be called satisfactory. Clensel, 1 part to 30 parts water, is the luring formula recommended. It is easy to mix, the traps remain clean, and the captured flies are easily visible.

Finally, it must be pointed out that foliage baiting and luring must be supplemented by complete orchard sanitation, which means that all infested fruits must be picked from trees or ground daily and destroyed.

Acknowledgment.—" Science Bulletin No. 143," Department of Agriculture, Union of South Africa.

SOME OBSERVATIONS ON THE METHODS OF MAKING CLARIFIED BUTTER (GHEE) WITH SOME NOTES ON A NEW METHOD*

IN hot countries milk and butter cannot be stored for any length of time. Also, in most of the dry, hot regions of the world, the yield of milk fluctuates considerably with the season of the year. The inhabitants of such semi-arid regions were forced to evolve a method of storing dairy products, prepared during the rainy period, for use during the drought period when no surplus milk can be obtained. Such a process was developed in India and has since spread to other sub-tropical countries. The original Hindustani name for this product was " ghi," and this term, written as " ghee," has been retained by most producing and marketing countries.

The principle underlying the production of ghee is the preparation, in a solid form, of milk fat free from water, proteins, and salts, *i.e.*, " clarified butter," as it is known in Western civilisation. The methods in vogue for producing this article vary greatly, from the crude native methods to the refined method of the European chef who prepares his " clarified butter " from high-quality fresh butter.

Theoretically th milk of any animal species could be used in the preparation of clarified butter or ghee, but in practice it is made chiefly from the milk of cows and buffaloes, though occasionally it is also derived from sheep and goat milk.

Ghee has been made in the East and particularly in India for centuries, but in India, which is still the largest ghee-producing country, it is nearly always adulterated. In fact most of the literature on this product is concerned with the detection of, or the legislation against, the adulteration of this article and very little has been written on its preparation. In India both animal and vegetable fats are used as adulterants, and many flavouring materials are also added. The quality of Indian ghee varies considerably, but to the average European who has lived in India the word " ghee " conjures up a picture of a dirty, oily fat with an offensive rancid smell. The term " clarified butter," on the other hand, makes one think of an attractive,

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* By M. H. French, M.A., Dip. Agric. (Cantab.), Biochemist, Department of Veterinary Science and Animal Husbandry, Tanganyika Territory, in *Bulletin of the Imperial Institute*, Vol. XXXIV., No. 1, (January-March, 1936)

[The new method of making ghee described on pages 58-60 has been tried at Peradeniya and found to give good results with a considerable saving in time and labour.—Editor T.A.]

yellow, wholesome article of food. Although both of these terms refer to the same article (butter fat) it speaks much for their methods of preparation that few people would connect the two products.

Ghee is made in most of the African Territories, but the native-made article is just as offensive in appearance, smell, and taste as is the average Indian product.

In Tanganyika Territory the Government have been fostering the production on a large scale of a good quality article capable of attracting a market in Western Europe. The efforts have been so successful that the present article has been written. It is proposed here to restrict the term " ghee " to the unattractive, native-made article, and to use the term " clarified butter " for the very good quality food now being produced under Government supervision.

In all the older methods of making ghee a large percentage of the water, protein and salts of the milk is removed in the first part of the operation by turning the milk fat into butter. In the second step the butter is heated and the remaining water is boiled off as steam. The protein is coagulated, precipitated and filtered off.

In the country districts of India, one still finds ghee being prepared by the old historic methods. Immediately after milking, the milk may be sterilised by heating it for an hour or more, but more often no sterilisation of this kind is carried out. The milk is put into a large earthen or brass jar and inoculated with a starter of sour milk. When the milk has curdled it is diluted with warm water and churned with a split bamboo or crude wooden vanes, which are twirled by hand, until the butter forms. The granules of butter are skimmed off the surface and allowed to stand for some time for excess water to drain away. During this interval much rancidity develops. The butter is then clarified by heating in an earthen or brass pot. After all the steam has boiled off the mixture is allowed to stand for the protein to sediment and then the liquid fat is poured off into containers.

In East Africa this is still the method used by many natives. The preliminary souring of the milk is done in gourds and churning consists of shaking the contents of the gourd until butter begins to form. The butter is collected and mixed with the butter from churning during several previous days. It is stored in an earthen pot and whilst standing gets thoroughly contaminated with dirt and insects. Boiling into ghee is done on a smoky wood fire when enough butter has accumulated to make this operation worth while. Native-made ghee prepared in this way is a white, tallowy, semi-liquid fat, smelling offensively and full of insects and dirt.

Kothavala and Cox (1) have recently pointed out the inefficiency of these old methods of manufacture when compared with modern procedures.

The first big step towards improving the method of preparation was the introduction of the separator and churn. The improved method which is being used in most countries employs both these instruments. The milk is separated as soon as possible after milking and the cream allowed to ripen, with or without the addition of a starter. The ripened cream is churned and the butter thoroughly washed, and after standing overnight is boiled into ghee. This method yields a very good article when carried out under European supervision.

During the past year much time has been spent in trying to improve the quality of the clarified butter produced by the Native Authority creameries. The natives and Indians, unless supervised by Europeans, produce a very inferior ghee even when using a separator and churn. No effort is made to keep the utensils clean and cream is often left for days until very rancid and mouldy before it is churned. Also, a long interval elapses between churning the butter and boiling it into ghee.

In Tanganyika Territory the native milks into gourds which are not very clean and as a result the milk rapidly turns sour. To overcome this difficulty milk tins, which are sterilised each day at the creameries, are supplied to the native for him to milk into directly and bring his milk to the creamery. It has been found, however, that the native still milks into his gourd and subsequently pours the contaminated milk into his clean tin. Native milk arriving at a creamery in East Africa may, therefore, be expected to and usually does, show a certain degree of rancidity. Cream separated from such milk will likewise possess a small amount of rancidity.

Work done during the last year has shown that, in spite of native milk having been well seeded with a very mixed bacterial population before it reaches the creamery, clarified butter of the highest quality can be produced from it. Laboratory trials have proved that the clarified butter made from locally-purchased native milk was just as good as that made from milk produced under the clean conditions of a Government dairy. One properly managed creamery has also dispensed with the milk tins usually supplied to the natives. The milk is brought to the creamery in the native gourds and no drop in quality has resulted.

The cream from native-produced milk possesses a very mixed bacterial content and probably not the types most suitable for producing the right type of acidity in the cream, or the finest flavour in the butter. Theoretically it is necessary to sterilise the cream and then seed it again with a starter containing the right bacteria. In practice this means extra work for the creamery staff and it would be almost impossible to keep a starter free from contamination with the undesirable bacteria which must be floating about in the air of a creamery in a hot district.

Experience in the creameries has now shown that cream ripens very quickly without the addition of a starter and possesses the right acidity for

quick churning in from 12 to 18 hours. The addition of a butter-milk starter is very liable to cause over-ripeness of the cream and results in more difficult churning and a poorer quality of butter.

Much depends on the butter being churned correctly. In Tanganyika Territory metal rotary churns have been adopted as the most suitable. They are very easy to keep clean, even when this is left to a native, and require no attention during the close season. The instructions of the makers should be followed very carefully, though the amount of washing that has been found necessary is much more than they recommend. Six washings of the butter is now the recognised procedure in the creameries. Over-churning the butter must be strictly avoided, because if this happens the butter loses its grain and becomes lumpy and is then most difficult to wash properly.

Tests made on fresh butter correctly churned and well washed have shown that it possesses no trace of rancidity. On the other hand, samples of good butter that have not been washed sufficiently show a slight rancidity. All butter that has been over-churned shows a rancid reaction and it is practically impossible to free completely such butter from the butter-milk.

In the past it has been the practice of the creameries to churn the butter one day and then allow it to drain until the following day before boiling it into ghee. It has been shown that even good, well-washed butter, when allowed to stand 24 to 30 hours in a native creamery, develops a definite rancidity in the surface layers. The extent to which the butter has become rancid depends upon the quality. Poor, insufficiently-washed butter gives a rancid reaction even from the interior of the lump. It has now been adopted as a standard routine that all butter must be boiled into clarified butter on the day of churning.

During the boiling of the butter, the proteins are precipitated and the water is removed in the form of steam. The lower molecular fatty acids produced by the lipolytic action of micro-organisms are slightly soluble in water and distil off in the steam. This means that butters possessing but a slight rancidity when put on to boil lose all these volatile acids during clarification. On the other hand, it has been shown that in those butters which have developed a pronounced rancidity the usual period of boiling is not sufficient to remove all the volatile products and the clarified butter may show a small amount of rancidity. Even this can be overcome, as happens in Indian-made ghee, by boiling for a longer period. However, this over-boiling results in an inferior product, which does not possess the solidity, grain, colour or taste of the good clarified butter from the creameries.

Therefore, for the production of good clarified butter from ordinary butter the following points are of particular importance :—

(*a*) The cream should ripen for as short a period as possible. Usually starters will not be found necessary in hot countries,

(*b*) The butter must be churned correctly and then very thoroughly washed.

(*c*) Butter should be clarified as soon as possible after churning.

(*d*) The butter must be correctly boiled.

The boiling of the butter is not such an easy procedure as one would at first imagine. Boiling must take place steadily and be neither too slow nor too fast. Many trials have been made by the Veterinary Staff to find the best type of stove for boiling. Wood is the fuel used in all creameries and much difficulty was at first experienced owing to the wood being wet. If boiling is to be uniform, the wood must be quite dry. Charcoal is used as the fuel in some countries, but it seems unnecessarily expensive.

Boiling takes place much more uniformly if the top of the stove is recessed to take the boiling pan. The flames of the fire should never play directly on to the pan, which should rest on a metal surface covering the fire. Great care is necessary to see that the smoke is led away properly, because clarified butter readily acquires a smoky taint. The boiling pan should be of metal and have as large a diameter as possible, because in this way heating takes place much quicker than in a deep, small-bottomed pot.

Clarifying the butter is regarded as an art and it is quite impossible to lay down rules as to the correct period necessary if boiling is to proceed at the optimum rate. There are so many factors involved that the time is never constant in any one creamery. Thus 56 lb. of butter may take anything from 20 to 90 minutes to clarify correctly. Further, it is impossible to say that boiling should be continued until a definite temperature is reached. I have found that the final temperature of the clarified butter when ready to be removed from the fire may vary between 110°C. and 140°C., but usually averages about 128°C., for many boilings both in the laboratory and in the creameries. When using good quality butter, I recommend that the boiling should be as brisk as possible without running the risk of the molten butter foaming out of the boiling pan.

As examples of the variations in times of boiling, Table I shows the protein, moisture and temperature changes of the clarifying butter as the boiling period is lengthened.

TABLE I

CHANGES IN THE COMPOSITION OF BUTTER DURING CLARIFICATION

Sample No.	First Test				Second Test			
	Interval of time	Temperature	Moisture	Protein	Interval of time	Temperatue	Moisture	Protein
	Mins.	°C.	Per cent.	Per cent.	Mins.	°C.	Per cent.	Per cent.
No. 1 (Butter) ..	0	24	18·52	0·92	0	28	14·82	0·58
No. 2	5	94	14·53	0·88	20	94	13·2	0·35
No. 3	10	94	9·95	0·55	30	94	10·5	0·29
No. 4	18	96	1·07	0·42	40	98	3·0	0·17
No. 5	23	108	0·39	0·36	50	114	0·2	0·09
No. 6 (Clarified Butter ..	28	130	0·01	0·03	58	124	0·00	0·02

The first test took less than half the time required by the second, yet the final product is just as good.

Rules can be laid down whereby the operator can judge correctly the point at which the butter is clarified and ready to leave the fire. The physical changes taking place are as follows :

(*a*) Butter commences to melt at 30°C., and by the time the temperature has risen to 64°C., all the butter will have melted.

(*b*) A foam forms on the surface and this increases in volume until a temperature of 94°C. is reached.

(*c*) The liquid butter starts to simmer at 94 to 96°C., and the temperature remains about constant until nearly all the water has boiled off.

(*d*) The contents of the boiling pan become much thicker and resemble thin custard. As the last of the water is boiling off at 98°C., bubbles begin to break with sufficient violence to cause a small amount of spitting.

(*e*) The curd begins to form into lumps as the temperature approaches 110°C. Many large bubbles break on the surface at this stage and much of the protein precipitate is carried up and forms a scum on the surface.

(*f*) The protein particles contract as the temperature gets near to 120°C., and sink to the botton of the pan. The scum disappears from the surface and the general appearance is that of a clear, amber-coloured liquid with white protein particles in suspension near the bottom of the pan. If boiling is stopped at this point the ghee possesses a peculiar smell which is aptly termed " unripe " by the natives.

(*g*) As the temperature rises above 120°C., the large bubbles are gradually replaced by smaller ones, until suddenly a foam of small bubbles is formed closely resembling in appearance " soap-suds." This foam rises rapidly and at this point the pan must be quickly removed from the fire.

A method of checking if the correct point has been reached is to observe the colour of the protein sediment as soon as the bubbles disappear. If these particles are lighter than the supernatant butter fat then boiling has been stopped a little too soon. These particles take on a slightly darker colour than the liquid if clarification is complete. When the fat has been over-boiled the protein sediment becomes charred and black.

When correctly boiled the clarified butter is filtered into containers.

During boiling it is very necessary that the contents of the pan are stirred gently and continuously, otherwise charring will take place and the quality be ruined. When the protein curd begins to sediment it is essential that vigorous stirring be avoided, otherwise the clarified butter will be cloudy in appearance due to the fine protein suspension which passes through the strainers.

Some authorities advise that the scum should be skimmed off during the clarification of butter. This point has been investigated and was found not to be necessary. All the protein removed by this skimming would be precipitated in any case, whereas its removal means extra work and boiling for the operator.

If overboiled the clarified butter loses its attractive colour and takes on a dirty white hue. It smells charred and tallowy and loses its grain, whilst in many cases it remains liquid. When kept simmering for a long time at a moderate temperature an oily product results, which never solidifies completely.

Work on the solidification of clarified butter has shown that small lots solidify much more quickly and uniformly than do large bulks. When filling large containers of 28 lb. capacity, or over, it is advisable only to fill the tin one-third full at a time. The first lot being allowed to solidify completely before subsequent lots are added. Very hot fat should not be poured on already solidified clarified butter, but should only be added when nearly cold.

It has also been shown that the containers must not be sealed whilst the fat is still hot, otherwise a vacuum is produced which considerably delays solidification.

Clarified butter should possess an attractive yellow colour and be either free from smell or possess a faint toffee odour. At all ordinary temperatures it should be solid, with a well-marked granular consistency. Normally it should have a sweet taste, free from rancidity, and in the best samples should resemble butter. When rubbed on the palm of the hand it should readily liquify. As clarified butter is free from protein and water it does not become mouldy or decomposed by the activity of micro-organisms. If well stored it will keep indefinitely.

There are certain deteriorating chemical changes which may take place in clarified butter. I refer to the autoxidation of the butter fat. This change is accelerated considerably by exposure to ultra-violet light, free contact with air, high acidity of the cream before conversion and is catalysed by the presence of certain metallic elements (iron and copper) (2). The autoxidation is accompanied by bleaching and the development of a tallowy smell and taste. Such changes are detected even in the early stages by the Kreis test ; all clarified butter prepared under veterinary supervision in the Territory is subjected to this test and only samples giving a negative reaction passed. Although autoxidation readily occurs under certain conditions, it does not take place if the fat is stored in full, sealed containers in the dark.

In an experiment at the laboratory, a sample of clarified butter was divided into seven lots and subjected to seven different treatments for a period of six weeks with the results shown in Table II. Each small sample was contained in a glass jar, which was completely filled to the stopper :

TABLE II

DETERIORATION OF CLARIFIED BUTTER BY AUTOXIDATION

Treatment	Effect on colour	Effect on taste	Development of positive Kreis test
Sealed with wax and exposed to sunlight	Nil	Nil	Nil
Loosely stoppered and exposed to sunlight	Slight bleaching round stopper	Tallowy only round stopper	Positive in top layers but negative beneath
Plugged with cotton wool and exposed to sunlight	Completely bleached	Tallowy	Strongly positive throughout even after diluting 1 in 20
Plugged with cotton wool and kept in the dark at 0°C.	Nil	Nil	Very faint trace in surface layer
Plugged with cotton wool and kept in the dark at 24°C.	Nil	Tallowy only in surface layers	Trace in surface layers only
Sealed with wax and kept in the dark at 24°C.	Nil	Nil	Nil
Loosely stoppered and kept in the dark at 24°C.	Nil	Nil	Very faint trace round the stopper

This experiment demonstrates how the Kreis test detects changes not yet apparent to the taste or in the appearance of the clarified butter.

Further, the results show that, in the absence of sunlight, autoxidation proceeds very slowly, even though the fat is exposed to the air (oxygen). Thus, if clarified butter is kept in filled metal containers it can be stored for very long periods. When the containers are opened, they should be kept in a dark spot or protected from sunlight. In the small samples tested in the laboratory a month was necessary for complete bleaching of a 30 gm. sample of clarified butter, even when continuously exposed to sunlight and air, so that under ordinary conditions a housewife need not fear that a large tin of clarified butter will deteriorate before she has used it up completely.

A NEW METHOD OF MAKING CLARIFIED BUTTER

In the older methods and in the method used in most countries today butter is prepared and clarified later. It has been pointed out above that the ripening of cream cannot be controlled very easily owing to the risk of contamination by undesirable types of bacteria. These unwanted bacteria give rise to many side products which though present in minute amounts detract

from the flavour of the butter produced. Also over-ripening of the cream with a large production of acid results in a butter of poor-keeping qualities. Further, even when clarified, butter from highly acid cream is more liable to autoxidation than if made from cream of the right acidity.

Also the butter has to be churned correctly otherwise efficient washing is impossible and the resulting clarified butter possesses some of the rancidity developed during the ripening of the cream.

If there is to be any large production of clarified butter much of the work will have to be left to natives. This means that the less skilled the work, the more capable will the native be to carry it out. The making and washing of butter is a skilled business, but turning a separator is mechanical. Clarifying butter has been regarded as an art, though, as shown earlier, if certain observations are made then it loses its right to be regarded as such.

In any case the boiling process cannot be eliminated.

In an effort to simplify the production of clarified butter so that a first-class article could always be turned out, the direct boiling of cream was tried. Cream contains very much more protein and water than butter and the only reason for making butter as an intermediate step in all the older processes is to reduce the quantities of these before boiling.

As was to be expected, both in the laboratory and creamery tests on the boiling of fresh cream, the direct boiling was not a success.

The large amount of protein present caused some to stick to the bottom of the pan and char, thus reducing the quality of the final product.

An attempt was then made to reduce the amount of protein present by washing the cream with water. This was accomplished by mixing the cream with water so as to make a volume equal to half that of the original milk separated. This cream emulsion was then reseparated. By this means the protein content was reduced to about the same percentage as is found in butter. Laboratory trials showed that this washed cream could be clarified without difficulty. Further trials on this method have been made on the Government dairy farm and on a large scale in one creamery. All the reports show that this method is working perfectly satisfactorily under creamery conditions.

In this washed cream method the small amount of rancidity present in the freshly-separated cream from native milk is partially removed by washing. The small amount left in the washed cream disappears during boiling. The result is that the product can be guaranteed absolutely free from rancidity. Further, since it is made from fresh cream its keeping qualities are better than that from butter produced from acid cream.

By general consent this clarified butter is graded as the best turned out in the Territory. It has a good colour, is always solid below 30°C., and in my opinion is better than the best Indian-made article. Its taste resembles butter

very closely. The Vitamin A content of this fresh cream clarified butter is much (3 times) higher than in the normal creamery product.

The loss of butter fat in reseparating the milk will not be more than is lost in the butter-milk, the butter left in the churn and on the butter-working table. Yields from the creamery confirm the small scale laboratory tests that there is no appreciable difference in yield of clarified butter between the standard and the new methods.

The washing of the cream and reseparating is absolutely mechanical and eliminates the need for an intelligent butter maker. This means that there is a saving on the utensils and skilled labour whilst a better product is turned out.

SUMMARY

An outline of the old and improved methods of making clarified butter has been given with notes on the quality of the product.

Certain improvements in the method of preparation from butter have been suggested as the result of recent work in Tanganyika Territory. These include (*a*) the shortest possible interval of ripening the cream, (*b*) thorough washing of butter and its immediate clarification, (*c*) correct boiling of the butter.

The clarification process has been studied and rules formulated to enable the end point to be judged correctly.

Some factors which affect solidification have been discussed.

A new method of preparation from washed fresh cream has been described. This method is more simple and foolproof than the butter method. Clarified butter of the best quality is made by this method.

REFERENCES

1. Z. R. Kothavala and S. Cox.—" Results of the Experiment in Ghee Making by the Desi (Country) and Separator Methods conducted at the Government Creamery, Amand." *J. Cent. Bur. Anim. Husb. India* (1927-28, 1, 95-97).

2. L. H. Briggs.—" The Autoxidation of Butter Fat. I. Factors influencing the Reaction. II. Comparison of Tests for Detecting Oxidation Changes." *J. Dairy Res.* (1931, 3, 61-79).

CORRESPONDENCE

AGRICULTURAL IMPLEMENTS

Dunuwila Walawwa,
Katugastota,
30th January, 1937.

The Editor,
"Tropical Agriculturist,"
Peradeniya.

Dear Sir,

I have read with interest the first two articles on Agricultural Implements by Mr. C. R. Karunaratne, Agricultural Instructor, which appeared in the November and December numbers of your journal for 1936.

Our agricultural implements, especially the implements used in paddy cultivation, are still those handed down to us by our forefathers. We have continued to use them, never once thinking of improving them or replacing them with simple improved implements such as those Mr. Karunaratne describes. I personally know that the Department of Agriculture is trying to introduce a better paddy plough but we are very slow to adopt anything new, however good it may be.

Having now an idea of what a seed drill is, and how much valuable seed now wasted can be saved, it would be interesting to know if a seed drill can be used to sow paddy. At present we sow sprouted paddy on soft mud but there is no reason to think that it is not possible to sow ungerminated paddy.

Yours faithfully,
C. Dunuwile.

TEA RESEARCH INSTITUTE OF CEYLON

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held at the Ceylon Chamber of Commerce, Colombo, on Saturday, October 10th, 1936, at 10 a.m.

Present.—Mr. James Forbes (Jnr.), (Chairman), The Acting Director of Agriculture, Major J. W. Oldfield, C.M.G., O.B.E., M.C., Messrs R. G. Coombe, C. E. Hawes, I. L. Cameron, D. T. Richards, D. H. Kotalawala, M.S.C., R. P. Gaddum, B. M. Selwyn, Dr. R. V. Norris (Director and Secretary) and, by invitation, Mr. J. W. Ferguson (Visiting Agent) and Mr. F. J. Whitehead.

Absent.—The Hon'ble the Financial Secretary and Colonel T. G. Jayawardene, V.D.

The Notice calling the Meeting was read.

Minutes of the Meeting of the Board of the Tea Research Institute of Ceylon held on the 20th June, 1936, were confirmed after correction of the date shown for the Institute's Conference.

MEMBERS OF THE BOARD

(*a*) Reported that Mr. C. E. Hawes assumed Membership of the Board as from the 7th August, 1936, on his election as Chairman, Ceylon Estates' Proprietary Association, vice Mr. E. L. Fraser.

The Chairman in welcoming Mr. Hawes referred to the excellent work he had previously done for the Institute. He also asked the Board to record a vote of thanks to Mr. E. L. Fraser for the services rendered by him.

(*b*) Reported that Mr. A. G. D. Bagot had been nominated by the Planters' Association of Ceylon to act for Mr. James Forbes (Jnr.) during the absence of the latter on leave.

SUB-COMMITTEES

(*a*) *Finance Sub-Committee.*

(I) Reported that Mr. C. E. Hawes had replaced Mr. E. L. Fraser.

(II) The Board nominated Mr. B. M. Selwyn as an acting member of the Committee, vice Mr. J. D. Hoare on leave.

(*b*) *Experimental and Estate Sub-Committee.*

(I) Reported that Mr. J. T. Young had accepted the invitation of the Board to join this Committee, vice Mr. I. L. Cameron resigned.

(II) The Board approved the nomination of Mr. L. C. A. Leefe to act for Mr. R. H. Horne during the absence of the latter on leave.

FINANCE

(I) The accounts to 31st August, 1936, were tabled and approved without comment.

(II) Reported that the State Council had sanctioned a reduction in the rate of interest on the Government Loan to the Institute to 5½ per cent. as from October, 1935.

Reported that the charges due on the Loan for the year 1935-1936 had been duly met on the 27th September.

MINUTES OF THE MEETING OF THE EXPERIMENTAL & ESTATE SUB-COMMITTEE HELD AT ST. COOMBS ON THE 23rd JULY & THE 26th SEPTEMBER, 1936

Phloem Necrosis of Tea.—The Board approved of work on this disease being carried on on St. Coombs Estate.

New Openings 1937.—The Board approved the proposals of the Experimental and Estate Sub-Committee in regard to the new opening of 20 acres in 1937, *viz.*,

(I) Five acres to be opened as an experimental area.

(II) An area of approximately 2 acres to be opened on the contour system.

(III) The balance of the acreage to be opened on normal lines.

ST. COOMBS ESTATE

Factory Machinery.—Reported that the new Empire 3′ Drier was now in use and it was expected the Davidson machine would be installed in November. The small scale experimental drier would probably be erected by the end of October.

JUNIOR SCIENTIFIC STAFF

Field Assistants.—Reported that Mr. J. W. Reith, Field Assistant to thr Plant Physiologist, has resigned his appointment as from 30th September and that Mr. F. P. Jayawardene had been appointed in his place.

ANY OTHER BUSINESS

(*a*) *Publications.*—The Board expressed its appreciation of Dr. Eden's Report on his visit to N.-E. India.

(*b*) *Chairmanship of the Board.*—Mr. Forbes said he was proceeding on leave at the end of the month and it would be necessary for the Board to elect another Chairman. He wished to thank members most cordially for the support and co-operation they had always accorded him and also to record his appreciation of the loyal assistance he had received from the Director and Scientific Staff at St. Coombs. His work as Chairman had been of absorbing interest to him and he would vacate the chair with very much regret.

Mr. Hawes, who was supported by Mr. Coombe, expressed the hope that Mr. Forbes would resume the Chairmanship on his return from leave ; in that case it would only be necessary to elect an Acting Chairman.

Mr. Gaddum then proposed, and Mr. Cameron seconded, that Mr. R. G. Coombe be appointed to act as Chairman during the period of Mr. Forbes' absence on leave.

Mr. Coombe said he would be willing to act provided he was assured Mr. Forbes would resume the chair on his return. Mr. Forbes had rendered notable service to the Institute and they were all most grateful for what he had done and wished him a very pleasant leave.

Mr. Gaddum's resolution was then put to the Meeting and carried unanimously.

The meeting then terminated with a vote of thanks to the chair.

ROLAND V. NORRIS
Secretary

RUBBER RESEARCH SCHEME (CEYLON)

Minutes of the thirty-fifth meeting of the Board of Management held in the Committee Room of the Ceylon Chamber of Commerce, Colombo, at 10 a.m. on Thursday the 12th November, 1936.

Present.—Mr. E. Rodrigo, C.C.S. (in the chair), Mr. C. H. Collins, C.C.S. (Deputy Financial Secretary), Messrs I. L. Cameron, L. M. M. Dias, L. B. de Mel, J.P., U.P.M., Col. T. G. Jayawardena, V.D., Messrs J. C. Kelly, F. A. Obeyesekera, J. L. D. Peiris, C. A. Pereira, B. M. Selwyn and Col. T. Y. Wright.

Mr. T. E. H. O'Brien, Director, was also present by invitation.

Apologies for absence were received from Messrs F. H. Griffith, M.S.C., R. C. Kannangara, M.S.C., and E. C. Villiers, M.S.C.

MINUTES

Draft Minutes of the thirty-fourth meeting which had been circulated to Members were confirmed and signed by the Chairman.

MATTERS ARISING FROM THE MINUTES

(*a*) *Application for grant from the Department of Industries.*—A letter from the Minister for Labour, Industry and Commerce informing the Board of the conditions on which a grant for the purchase of machinery would be recommended, was considered and the terms of reply decided on.

(*b*) *Report of Sub-Committee on terms of service of Officers recruited from abroad.*—The report which had previously been circulated to Members was approved after discussion. A vote of thanks to the Sub-Committee was adopted.

BOARD MEMBERSHIP

The Chairman reported that Mr. F. H. Griffith, M.S.C., had been re-nominated by the Planters' Association of Ceylon as one of its representatives on the Board for a further term of 3 years from the 15th November, 1936

DECISION BY CIRCULATION OF PAPERS

Manuring at Dartonfield.—The Chairman stated that a recommendation of the Experimental Committee to complete the manuring of the estate in the current year, had been submitted to Board Members for approval by circulation of papers but a Member had asked for the matter to be postponed for decision at a meeting. After discussion it was decided to postpone manuring until next year in view of the difficulty of completing the programme before the feeding roots became dormant, prior to the wintering period.

ACCOUNTS

(*a*) *Estimates for* 1937.—Draft estimates which had been circulated to Members, were considered in detail. After discussion the following estimates were adopted :—

Revenue			Rs. 163,760
Expenditure on Revenue Account ..		Rs. 135,982	
Expenditure on Capital Account—			
Buildings	Rs. 61,000		
Equipment	Rs. 2,000		
Agricultural Development	Rs. 6,072	Rs. 69,072	Rs. 205,054
Estimated Credit Balance at December 31st, 1937			Rs. 49,616

(*b*) Dartonfield and Nivitigalakele accounts for July and August, 1936 were tabled.

STAFF

(*a*) *Director's Service Agreement.*—Decided to have agreement drafted on the basis of the terms adopted earlier in the meeting.

(*b*) *Renewal of Agreement of Botanist and Mycologist.*—Decided to offer re-engagement to Mr. R. K. S. Murray on the basis of the terms adopted earlier in the meeting.

(*c*) *Leave for Botanist and Mycologist.*—Application for Mr. R. K. S. Murray to proceed on home leave on January 20th, 1937 was approved.

EXPERIMENTAL COMMITTEE

Recommendations made at meeting of 13th October.

(*a*) *Visiting Agent's Report.*—Report adopted.

(*b*) *Price of Manufactured Goods.*—A recommendation regarding the price at which vulcanized goods manufactured at Dartonfield should be sold, was onsidered. The Director was asked to submit a list of products available in addition to rubber tubing.

TECHNICAL OFFICERS' REPORTS FOR 1st, 2nd & 3rd QUARTERS, 1936

The Chairman expressed regret that the reports had not been submitted for consideration earlier and said that future reports would be brought before the Board as soon as available. Attention was drawn to the fact that there had been a confusion of clones in a plot of the 1935 replanted area. It was noted that the matter had been fully investigated and the error traced to 2 or 3 plants which were budded when the clone was originally introduced at Nivitigalakele.

The reports were adopted.

RUBBER COUPONS

It was decided that surplus coupons should be sold before the end of the year.

The meeting closed with a vote of thanks to the Ceylon Chamber of Commerce for the use of the Committee room.

REVIEW

Burma Fruits and their Cultivation (Department of Agriculture, Burma. Bulletin No. 30), by J. W. Grant and A. N. P. Williams, Rangoon. Government Printing and Stationery, Burma, 1936. Re. 1-8 = 2*s*. 3*d*.

THIS bulletin should be in the hands of all interested in fruit cultivation in Ceylon. It embraces much detail in regard to soils, cultivation, and the best methods of propagating the tropical and sub-tropica, fruits dealt with which are botanically classified. The area under the cultivation of fruit in Burma amounts to nearly 440,000 acres within which there is a considerable range of climate and the rainfall varies from 32-240 inches per annum. Consequently, the fruits cultivated are varied. Of this acreage an area equivalent to 92 per cent. is situated in the wet zone of lower Burma, the most important tract being the Tennasserim Division where mangoes, mangosteens, durians, plantains, and pineapples predominate. In the Irrawaddy and Pegu Divisions, where the soil and climatic conditions are less favourable, the range of fruit is more restricted, whilst the drier districts of Prome and Tharrawaddy produce mainly the custard apple and orange.

The lower rainfall of Upper Burma renders conditions less favourable for the cultivation of most fruits but favours the plantain, which is produced in large quantities, and a few other fruits as the mango, jak, jujube, fig, and grape. With the exception of plantains which are cultivated on orchard lines, production is mostly from mixed gardens.

As in the case of Ceylon, Burma is far from self-supporting in the matter of fresh fruit supplies and this bulletin has been prepared with the object of indicating how the country could be made less dependent upon imports if the peasant and small capitalist could be induced to extend the cultivation of fruit to suitable areas which are now undeveloped.

Much emphasis is rightly placed on the utilisation of only the best quality of planting material in new plantations, with a rigid insistence on regular and good cultivation subsequently. Whilst there is yet no export trade in fruit, small trial consignments of mangosteen and mango have been undertaken with favourable results.

The bulletin comprises four chapters, the first affording interesting information on cultural operations, planting, cover crops, manures, pruning, and remedies for insect and fungus attacks. The triangular mode of planting is particularly stressed. Chapter two is devoted to the various methods of

propagation, many of which are illustrated as are, also, a number of agricultural implements employed in cultivation in Burma. In chapter three, the respective fruits are arranged and dealt with alphabetically in their natural orders with full botanical descriptions of the species. Chapter four deals with marketing and stresses the very unsatisfactory nature of the methods at present employed. As in Ceylon, this is to be attributed to small production, the perishable nature of most tropical fruits, the methods, or lack of methods, of plucking and packing, and the poor facilities for transport and storage. Much valuable information is afforded as to the correct method to adopt in plucking, the stage of ripeness at which to pluck, the mode of packing and grading and many other features essential to the disposal of good fruit to the best advantage.

An index of the contents has been carefully compiled enabling any particular fruit to be readily located under its common name by those who are not sufficiently versed in the botanical nomenclature of this subject.

Ample information is afforded as to the best cultural methods to be applied to each fruit and manner in which such fruit is utilised.

The mango in Burma is propagated chiefly from seed. Inarching is practised but not grafting. The wedge graft method might be tried with advantage. The majority of the mangoes of Burma are polyembryonic, a condition which is not common in Ceylon except in the case of certain Jaffna varieties. Seedling plants in Burma do not, in consequence, result in much variation. Manures are applied either just before or at the end of the rainy season and before the trees begin to flower.

The durian, which is limited to certain divisions, occurs in semi-cultivated stands and is not cultivated on orchard lines. In Ceylon a durian tree planted in an isolated position shows every sign of self-sterility which suggests the necessity for planting this fruit tree in groups.

The mangosteen grows to perfection in the hot, moist climate of Tennasserim, and large gardens of this fruit are in cultivation. Propagation is almost entirely by seed though grafting on the Cochin " goraka " and other stocks is being tried.

The jak tree is found throughout Burma in gardens and in jungles in both wet and dry zones. The two Burma varieties, " kala " and " talaing," appear to correspond to our " waraka " and " wela." The latter variety cross pollinates freely and the seedlings are mixed but the " wela " predominates. Two distinct leaf forms are observable in most beds of seedlings and further investigation should enable each variety to be distinguished by the character and form of the leaves.

Citrus is not commonly grown, though the lime, pumelo, citron, and lemon occur. The lime is more common, but importation from India is

necessary to meet the local demand. The mandarin is produced in the Shan States though there is little systematic cultivation in any of the groups.

Other main fruits such as pineapple, papaya, plantain, and sapodilla are very fully dealt with, as are, also, many minor fruits including pomegranate, jujube, passion fruit, litchi, rambuttan, Cape gooseberry of the tropical varieties. Peach, pear and plum are grown in the Shan States. The wide range of fruits dealt with, and the useful and very practical notes on cultivation, indicate a very critical and sound survey of the Burma fruit districts on which the authors of the Bulletin are to be congratulated.

Publications on tropical fruits are too few and the appearance of this bulletin at the present stage of fruit production in the tropics will be appreciated by all who are interested in this branch of horticulture.—T.H.P.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED DECEMBER, 1936.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st, 1937	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	3347	..	3347	..	..	..
	Anthrax	..	..	..	..	..	..
	Rabies	21	1	..	..	..	21
Colombo Municipality	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	1356	9	1324	23	9	..
	Anthrax	1	..	..	1	..	..
	Rabies	43	4	..	43*	..	..
Cattle Quarantine Station	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	3	..	3	..	..	..
	Anthrax	27	2	..	27	..	..
Central	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	3216	432	2845	12	359	..
	Anthrax	11	..	..	11	..	..
	Rabies	13	1	..	13*	..	..
	Tuberculosis	2	..	..	2	..	..
		3	..	2	1	..	..
Southern	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	119	..	119	..	..	..
	Anthrax	..	..	..	..	..	..
Northern	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	2825	2512†	2605	199	21	..
	Anthrax	..	..	..	..	..	..
Eastern	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	36	..	36	..	..	..
	Anthrax	..	..	..	..	..	..
North-Western	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	3859	..	3765	7	87	..
	Anthrax	..	..	..	..	..	..
	Rabies	41	5	..	4	37	..
North-Central	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	1308	76	1210	98	..	..
	Anthrax	..	..	..	..	..	..
Uva	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	21	14	21	..	..	..
	Rabies	2	..	..	1	..	1
	Haemorrhagic Septicaemia	8	..	..	8	..	..
Sabaragamuwa	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	5899	78	5779	120		..
	Anthrax	..	..	..	..	..	..
	Haemorrhagic Septicaemia	10	..	..	10	..	..
	Rabies	3	..	..	..	..	3

*Destroyed
†Includes fresh cases during October, November & December, 1936

Department of Agriculture,
Peradeniya, 20th January, 1937

M. CRAWFORD,
Deputy Director of Agriculture (Animal Husbandry), & Government Veterinary Surgeon

METEOROLOGICAL REPORT—DECEMBER, 1936

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Ins.		Ins.
Colombo ..	84·8	−0·7	72·8	+0·4	76	93	7·4	7·94	16	+ 2·30
Puttalam ..	84·5	−0·1	71·8	+0·8	80	95	6·3	6.41	15	+ 0·21
Mannar ..	82·6	−0·6	75·2	+0·5	80	88	6·5	15·65	18	+ 7·84
Jaffna ..	83·1	+0·9	73·6	+1·1	78	90	7·4	9·48	17	+ 0·03
Trincomalee ..	81·3	+0·4	75·1	+0·6	82	88	7·6	25·05	24	+12·44
Batticaloa ..	81·7	−0·2	73·8	+0·4	80	90	6·9	35·28	22	+18·13
Hambantota ..	83·9	−0·4	73·0	+0·3	80	93	6·2	5·55	18	− 0·04
Galle ..	83·8	+0·2	73·8	+0·6	78	90	6·4	4·40	13	− 3·77
Ratnapura ..	86·5	−1·6	71·9	+0·2	71	95	7·3	10·51	19	+ 1·31
Anuradhapura ..	82·3	−0·6	71·0	+1·3	82	97	7·8	12·20	18	+ 4·59
Kurunegala ..	85·6	−0·4	70·7	+0·3	74	93	6·0	11·79	14	+ 4·66
Kandy ..	83·6	+1·0	67·4	−0·1	74	92	6·4	11·66	15	+ 2·60
Badulla ..	76·9	+0·3	65·1	+0·7	81	95	7·6	16·77	21	+ 5·37
Diyatalawa ..	72·1	+0·2	59·0	+0·7	84	94	7·8	13·16	21	+ 5·05
Hakgala ..	66·2	−0·1	53·8	+1·7	87	94	8·6	21·21	25	+ 7·85
Nuwara Eliya ..	66·8	−1·3	50·4	+1·9	82	97	8·8	15·53	21	+ 7·51

The rainfall of December was above normal except in the south where deficits were generally small, those over 5 inches being, 5·38 inches at Morawaka, 5·11 inches at Hiyare, and 5·06 inches at Ellawella. The excesses were most marked in the Eastern Province, in the eastern half of North-Central Province, and on the eastern slopes of the central hills. Excesses over 15 inches were 19·74 inches at Kanankadu, 18·79 at Lahugala, 18·13 at Batticaloa, 17·79 at Allai Tank, 17·78 at Divulana, 16·31 at Gala Oya, and 16·26 at Amparai.

The highest monthly totals were 45·64 inches at Lugaloya, 45·07 inches at Hendon, and 43·59 inches at St. Martin's, all on the north-eastern slopes and the central hills.

One hundred and seventeen falls of at least 5 inches in a day were reported during the month, a large majority of these having fallen on the 14th. The highest falls were 11·19 at Batticaloa and 10·00 in Uva Estate both on the 14th.

The weather was chiefly of the north-east monsoon type. During the first week rain was generally light and scattered. In the second week there was increased and more widespread rainfall over the Island, culminating in very heavy precipitation on the 14th. On the following two days also, rain was heavy, particularly on the north-east side. From the 16th to the 22nd, rain was widespread but generally light. Conditions were fairly settled from the 23rd to 28th, when practically no rain was recorded. As a result of a deep depression of very small extent to the east of Ceylon, weather became unsettled and rain was heavy and widespread on the 29th. This depression crossed over the Island very quickly, but continued to give moderate and fairly general rain in the last two days of the month. Local thunder was in evidence occasionally during the first three weeks.

The temperatures were generally about normal by day and a little above normal by night, the 30th, however, being an unusually cold day. Humidity did not deviate appreciably from average, while cloudiness was everywhere above average. The barometric pressure was a little low and the gradient was generally moderate north-westerly. Wind strength was on the whole above normal, while its direction was chiefly north-easterly.

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